Science & Mechanics

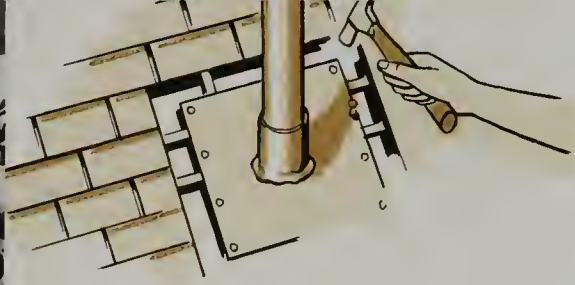
Complete HANDYMAN ENCYCLOPEDIA

19

TOOLS, GARDEN
UPHOLSTERY

Do-it-Yourself

Complete Handyman do-it-yourself Encyclopedia



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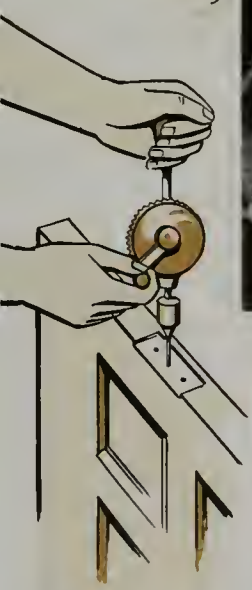

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- Boat Handling
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Complete Handyman yourself Encyclopedia

A COMPILATION OF NEW AND PREVIOUSLY PUBLISHED SPECIAL INTEREST PROJECTS AND MANUALS FOR THE REPAIR AND CARE OF HOMES, AUTO, APPLIANCES, HOBBY EQUIPMENT.

by the editors of

Science & Mechanics

19

TOOLS, GARDEN
UPHOLSTERY

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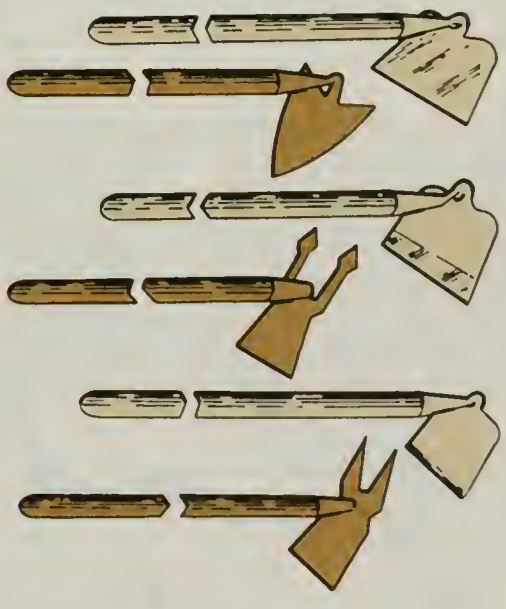
How to Choose Garden Tools

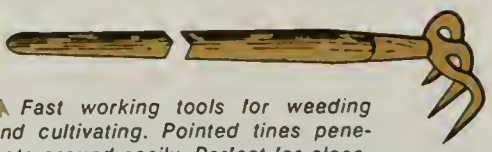
You will get much pleasure from your garden, if you choose the right tools to do the job

GARDENING IS AN ACTIVITY that is both healthy and gratifying. It gives you a chance to work out of doors, close to nature, and enables you to enjoy the fruits of your labor.

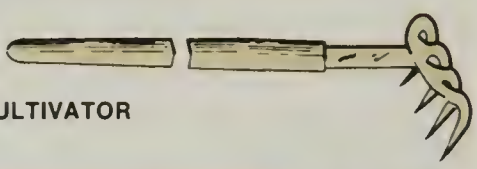
Much hard work goes into a well cared for garden and that work can be made easier if you use the right tools. Choose tools according to the use they are intended and to fit your individual requirements.

See also: FERTILIZERS; FLOWER CARE; FLOWERING BULBS; GARDENING; GARDEN PLANNING; GRAFTING; HERBS; LANDSCAPING; LAWNS; ORGANIC GARDENING; TREES.

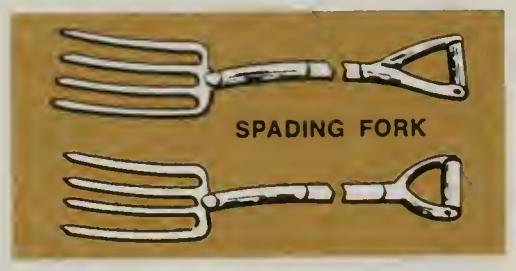




Fast working tools for weeding and cultivating. Pointed tines penetrate ground easily. Perfect for close-planted flower beds.



CULTIVATOR



Unless your soil is very sandy, a good fork is important in preparing a seedbed. Pick the weight that is suitable for you.

GARDEN AND WEEDING HOES

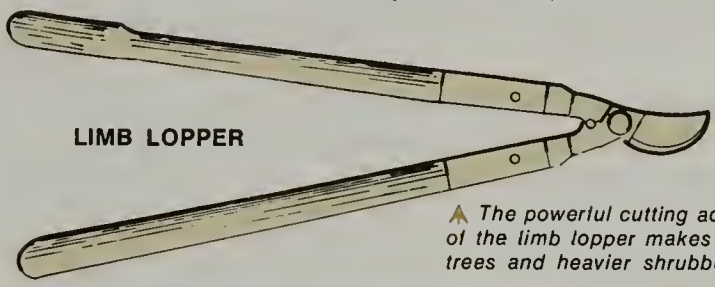
Blade size and shape determine its function. The standard hoe has a flat blade used to break the surface of the ground and to destroy weeds. Use the point of the heart-shaped cultivator hoe for drilling; top to cover seeds; sides for hilling. The weeding hoe has a forked side; use both sides for deep cultivating and weeding in hard, stony soil.

tools, hand: see hand tools
tool shed: see garden tool shed
tools, plumbing: see plumbing
tools, power: see power tools

POST HOLE DIGGER

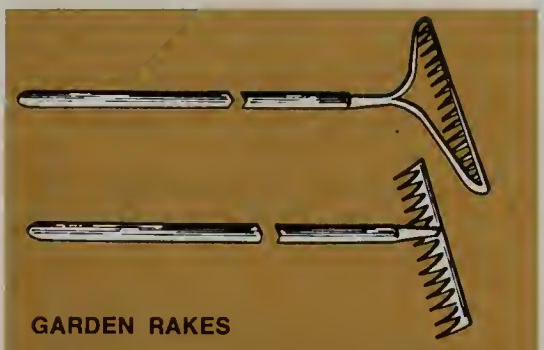
▲ *A handy tool to dig holes for fence posts, outdoor fixtures, post lights, mailboxes, etc.*

LIMB LOPPER

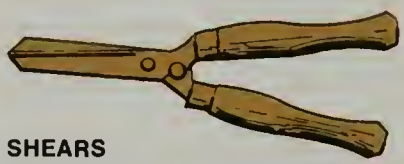


▲ *The powerful cutting action and long handles of the limb lopper makes light work of pruning trees and heavier shrubbery.*

GARDEN RAKES



Probably your most useful garden tool. Bow rakes are the most popular type. Spring bow braces head and turns aside tender shoots. Level head rakes are ideal for smoothing soil.

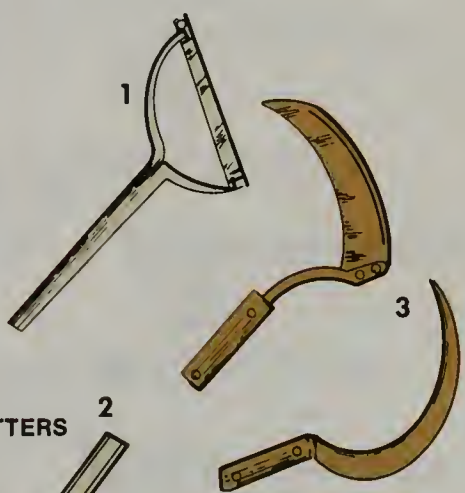


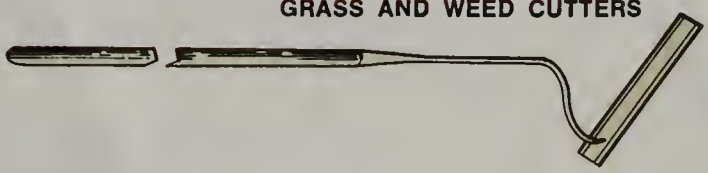
HEDGE SHEARS

▲ *For cutting light, woody growth. Can also be used for trimming grass or ground cover.*

GRASS AND WEED CUTTERS

▼ *Practically indispensible for cutting tall grass and on hillsides where a mower cannot reach. 1. Grass cutter cuts cleanly and easily with a golf-swing motion. Serrated, double-edge blade is removable for sharpening. 2. Use weed cutter for heavier growth using the golf-swing motion. 3. Grass hook (sickle) with scythe-type blade is a highly efficient grass cutter.*





DANDELION DIGGERS

The sharp, v-shaped blade of the dandelion digger cuts weed stems below ground. The short-handled digger can also be used to cut asparagus.

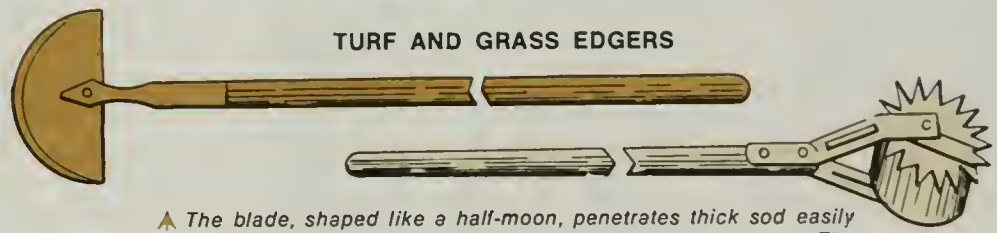
JUNIOR-SIZE TOOLS

These are real tools sized for youngsters so they can also enjoy gardening. Can be used by adults for light work.

LAWN AND LEAF RAKES

Lawn and leaf rakes have flat, spring-steel teeth shaped to pick up litter without injuring grass. The pull type has a straight edge that pulls litter away from walls and out of gutters. The sweep type is used like a broom and is ideal to get leaves out of hedgerows, flower beds, etc.

TURF AND GRASS EDGERS



The blade, shaped like a half-moon, penetrates thick sod easily for neat, straight borders around flower beds, walks and drives. The wheeled-type cuts grass as it rolls. Is ideal for cutting a neat edge along walks, curbs and drives.

Versatile tools with many uses in flower and vegetable gardens. 1. General purpose trowel. 2. Transplanting trowel. 3. Prong weeder for close cultivation around small plants. 4. Weeding hoe for cultivating. 5. Hand rake for leveling flower beds, boxes and pots. 6. Pointed hoe has furrowing blade and two prongs.

How to Choose the Right Saw Blade

There is a blade for every purpose, and some for several purposes. The one you select can make the difference between a good job and poor one, or between an easy job and a difficult one

EVEN THE SIMPLEST handsaw can deliver a variety of cuts through a variety of materials if you take the time to match the blade to the material and to the cut. When you are working with power saws, it's even more important to know what blade to use for each cut.

Some blades are designed to cut with the grain, some against it. Other blades are designed for use with plywood, metal, masonry or plastic. If you want the most from your power saw, if you want smooth-edged, accurate, splinter-free cuts: use the right blade.

Each part of a saw blade has a specific job and a special name. Here are the most important: tooth, a single cutting segment on a blade; kerf, the slot cut through the material by the teeth; face, the forward edge of the tooth; back, the after edge of the tooth; point, the highest spot on a tooth, the meeting of the back and the face; gullet, the lowest point on a tooth, the meeting of the back and the face; bevel, the angle at which the back and face of each tooth is ground; set, the angle at which the teeth are bent outward; hook, the line of the face tangent to the blade circle; raker, a tooth designed to rake or clean wood from the kerf rather than to cut or separate the fibers.

Each type of blade has a different arrangement or a different design for these elements. Crosscuts, made against the wood fibers, require blades with teeth of sharp, knife-like points which can cleanly sever the fibers. The upper edge of a crosscut blade tooth cuts the fiber, the slanted portion removes the waste material from the kerf. The teeth have fairly angular bevels, set alternately right and left to assure adequate blade clearance in the kerf to prevent binding. The point angle is critical. If it is too gentle, the teeth cannot cut cleanly; if it is too acute, the blade will dull quickly.

Rip cuts, made with the grain, do not present the same problems. There are fewer fibers to contend with and the teeth have flatter edges which work more like dozens of tiny chisels. The points have less bevel and there are fewer teeth per inch. Although the teeth are set right and left, as they are on a crosscut blade, the ripping blade makes coarser saw dust.

Some blades have a combination of both designs, with small teeth designed for crosscutting and larger ones with a deeper gullet

torque wrench: see hand tools
toys, animal: see handicrafts
toys, flashing: see craft projects
trace elements: see fertilizers
track, hideaway: see model car layout

that rakes or cleans the kerf exactly as a rip blade would.

No blade can work its way through wood without clearance between the blade and the material. Without a passageway, friction and heat would either ruin the blade or the material. Most blades gain this clearance by the set of the teeth. Since the teeth are angled outward from the body of the blade, the kerf is automatically wider than the blade. Some blades gain wider kerfs through hollow-grinding: a portion of the blade and the teeth, between the teeth and the center of the blade (where the body of the saw passes through the material) is ground thinner than the teeth.

Your first saw blade came with the machine and chances are it was a combination blade, one designed to deliver good results with a variety of cuts and woods. Such a blade is divided into segments with clusters of teeth grouped together. The teeth are basically crosscut in design with one raker in each segment, separated from other segments by a deep gullet. The design lets the blade work well with or across the grain.

A combination blade will deliver good results on most cuts, but when you want the best possible cut with the least possible disturbance to the wood, you'll need to add special blades designed for special cuts. The immediate impulse is to add both a rip and a crosscut blade. Too often, this is not the best choice.

Chances are you are not cutting strictly rip or crosscuts often enough to justify the purchase of these special blades early in the game. Save these blades for the time when you've moved into the "advanced amateur" class.

A better choice for a second blade is a finer combination blade or a planer blade.

➤ *Choosing the correct blade for the job can save labor all along the line. Here, a hollow ground planer blade is being used to make a smooth rip cut. The cut will provide a finished edge that will require no sanding.*

The planer blade, often called a miter blade, is a hollow-ground type one raker tooth and four cutting teeth with no set in each segment. It is capable of amazingly smooth work; cabinetmakers swear by it. This blade is used to cut wood to finished dimensions because it works smoothly with or against the grain. Even if you use a jointer to smooth rip cuts, you'll find a planer blade handy for crosscuts and miter cuts.

Plywood is a popular workshop material, but it is difficult to cut. A special plywood blade is a wise third choice. The fine-tooth plywood blade has a special thin-rim taper and works nicely on both plywood and gummy, resinous woods.

A planer blade can deliver good cuts on plywood, but if you use it often against the glued lines it will quickly dull. The special plywood blade can take this constant abrasion yet remain sharp. You'll also be able to use the blade on glued joints. It is available in thin-kerf versions for use on veneers.

Make your fourth blade a ripping blade. It is designed for just one job: cutting with the grain. Nothing can duplicate its work. Since ripping often loads the saw motor, a rip blade can add life to your saw.

These four blades—a combination, a finer combination blade or a planer blade, a plywood blade and a rip blade—will give you a good basic saw set, capable of handling most of the work you'll run into. Yet, there will be times when these cannot handle the work.

Special blades will be needed for special jobs. A good production blade with teeth set for good clearance is the hard-tip combination blade. The teeth are heat-treated for increased life and will stay sharp longer than those on a conventional combination blade. A hard-tip is a good blade and a good choice for any shop, but it is expensive and the teeth are harder to re-sharpen.

Carbide-tipped combination blade, similar to the hard-tip blade, has teeth that are tipped with tungsten carbide. The blade cuts like a conventional blade, but will stay sharp five to ten times longer. It's ideal when you are cutting hardwood, plywood, asbestos board and similar materials.

Carbide-tipped planer blade is a hard-tipped planer blade, more expensive than a conventional-tipped type but built to stay sharp much longer. The 10 banks of 5 teeth each will deliver an amazingly smooth cut on rip, crosscut or miter work. The blade is a natural for plywood, softwood and hardwood. It is as close as anything made to an all-around "universal" blade.

Cabinet combination blade is a fine-tooth blade that is excellent for cutting thin stock. Most shops use it on material to 1¼-inch thick. One type has 52 teeth with enough set for good blade clearance. Another version has 52 teeth with no set, and the teeth taper-ground for clearance. Both have special raker teeth to clean out sawdust.

Thin-rimmed blades have extra-fine teeth with special edges designed for cutting such delicate materials as veneer. These blades make fine kerfs for inlay work and waste very little wood.

Hard-to-cut materials are easily handled with a carbide-tip cut-off blade. It's excellent for laminated plastics, honeycomb panels and hardboard.

Silicon-carbide cut-off wheel, a blade-sized grinding wheel makes quick work of light metals, asphalt and vinyl flooring, masonry, even reinforced plastic. It has no

These teeth are typical of blades designed for ripping rather than cutting across the grain.

teeth and cuts by grinding or abrasive action.

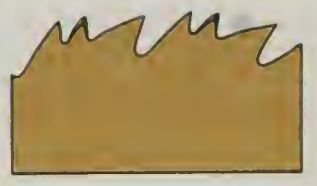
No blade is inexpensive, but you can get your money's worth if you'll take time to store blades properly. The easiest way is to protect them from other metals and from each other on hooks hung on perforated hardboard. Be sure the hooks are spaced to prevent the blades from touching.

A better system is to build a special storage case. Much like a record album, the blade case has laminated sections (of ½-inch plywood) to keep each blade safe. If you build a blade case, make it big enough: you may only own three blades now, but if you make the case to hold six or even ten blades, you'll have it filled soon enough.

Most blades can be sharpened at home, but since it costs very little to have an expert do the job, few people ever take the time to learn. Your local blade expert can sharpen most of your blades but the carbide-tipped versions require special equipment, and in most cases they are best sharpened by the factory. If you own a carbide-tipped blade, build a special wooden case for it. When the blade needs sharpening, use the case as a mailer.

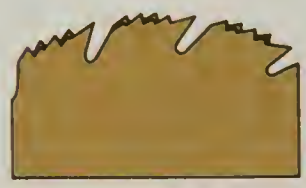
There's a definite relationship between the rpm of the motor on your saw and the blade diameter, a relationship which affects the speed at which you can feed material into the saw. Professional shops use an automatic feeder which gears the speed of the material to the blade size and motor rpm, but since you feed your saw by hand take time to develop a feel which will tell you the speed required.

It's easy to develop a "touch." If you push the work through too fast, the blade will slow—it may even stall. When the cut is made you'll be able to count the radial marks made in the cut by the slow-moving blade. If you push the work through too slowly the blade or the material may heat. At the right speed you get a smooth, accurate, cool cut.

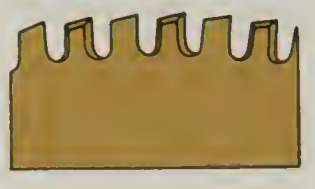


This combination blade, with two cutting teeth and one raker tooth per section, is designed for either crosscutting or ripping.

Typical crosscut saw teeth.



Planer teeth provide a cut with a finished edge that ordinarily requires no sanding. It is a combination type and can cut in any direction relative to the grain of the wood.



The teeth of a blade designed to yield smooth cuts in plywood.

Listen to the motor and blade hum as they run free. Try running material through the saw without changing this sound. Increase the feed speed until the sound level

does change, then back off. This point should be the proper feed-speed for that blade and motor combination. Once you've found this proper speed, the only change in blade sound should come when the blade itself dulls.

Cutting efficiency is governed as much by the amount of blade projecting above the table (or into the wood) as by the rpm and blade size. On a radial saw the projection is governed by the depth of the cut, but on a table saw the projection is governed by the operator. A low projection exposes less of the blade. It is safer, but it can give a slightly rougher cut and make the motor work harder. A higher blade projection cuts easier and cleaner but is more dangerous. The best projection is a compromise ¼- to ½-inch above the material.

This saw blade is for fine work. It can cut with or against the grain and is a good general-purpose home workshop blade, although it cuts more slowly than some other blades.

The carbide cutting tips of this general-purpose combination blade stay sharp many times longer than ordinary saws. Another feature of the design is that the high area behind each cutting tip regulates the depth of the chip that the saw cuts and, in effect, regulates the rate of feed.

You'll find a hollow-ground blade requires more projection than a conventional-ground type. A low-projection puts too much of the rim (which is thicker) in the kerf. A higher projection raises the blade to increase clearance.

The kerf should be just as wide as the set of the teeth and you should check periodically to be sure the kerf is not abnormally wide. If the kerf is too wide, remove the blade and check the blade and the arbor collar. Chances are a small piece of dirt or a small chip has become lodged between the blade and the collar, angling the blade so it doesn't turn in a true plane. If not, check the mounting, the bolt and nut: these could be bent or out of alignment.

Each time you remove a blade, check the arbor, threads and collar. Always remount the blade in exactly the position it was in when removed. It's a good idea to mark the arbor (a slight file or prick punch mark will do it), but don't mark the threads. Always turn the arbor mark upright before you remove the blade, and when you remount. Keep the blade mark at the top, in line with the arbor mark.

The reason is simple: if the arbor hole in the blade were the exact diameter of the arbor, it would be impossible to install the blade. The hole is a fraction of an inch

BLADE RECOMMENDATIONS

	Material	Comb.	Cross-cut	Rip	Planer	Spec. Plywood	Carbide	Dis-scroloy	Flooring	Trimmer
SOFT WOOD	General	A					C			
	Crosscut	A	B		A		A			C
	Rip	A		C	A		A			
	Miters	A	B		C	A	A			A
HARD WOOD	General	A					C			
	Crosscut	A	B		A		A			C
	Rip	A		C	A		A			
	Miters	A			C		A			A
OCCASIONAL NAIL	Flooring, old lumber, etc.								C	
FIBROUS, POROUS MATERIALS	Acoustical tile, Celotex, etc.				C	B	A	A		
METAL	Non-ferrous							C		
	Do-it-yourself aluminum		A					A		
PLASTICS								C		
PLYWOOD			A		B	C	B			
PLASTIC LAMINATES	Micarta, Formica, etc.						C	A		
HARDBOARDS	Masonite, etc.						C			
FIBERGLASS	Corrugated sheets		A				C		A	
ALUMINUM	Corrugated sheets		A				A	C	B	

A indicates blade very good for the job
B suggests a better blade for the job
C is a blade that will do the very best job possible

larger to make it easy to slip the blade on the shaft. This "over-size" is considered when the blade is "jointed," a sharpening procedure which makes all teeth the proper height. If you mount the blade trade-mark up, it's in the position the manufacturer intended. In other positions it could be slightly out of round.

Saw blades will sooner or later accumulate deposits. Gum and pitch are the worst offenders and they can destroy the efficiency of any blade unless they are removed.

Hardwood and redwood gum can be removed by soaking the blade in hot water. Commercial pitch removers, household ammonia, kerosene or turpentine can be used to remove most pitch. Apply the solvent with a brush (a toothbrush is just the right size). Let the solvent soak into the pitch, then wipe the blade with a soft, clean cloth.

When you clean a blade with water, or if you plan to store it, coat the full blade with a light layer of oil. Keep your blades bright, clean them often, then protect them with a hard paste wax. If you use the proper blade and give it the right kind of care, you'll get years of life from both your saw and the blades.

B.B.

See also: POWER TOOLS; RADIAL ARM SAW; SAW; SHARPENING; TABLE SAW; TOOLS.

Twin-blade Cutting with a Table Saw

You can use the same techniques that milling shops use, but on a smaller scale, to speed the passage of work past your table saw

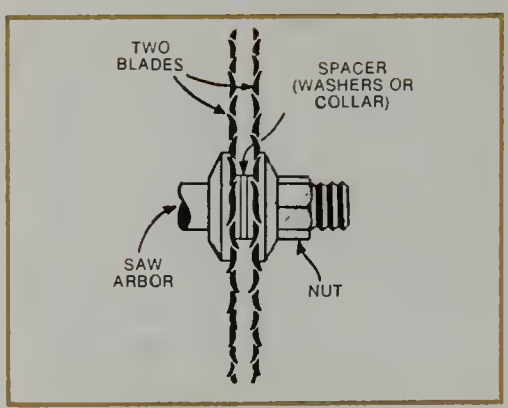
MOST TABLE-SAW ARBORS are long enough to accommodate more than one saw blade and you can take advantage of this feature to speed up common cutting jobs, or to make special setups for particular operations.

The secret behind this trick of power-tool woodworking is nothing more than the placement of washers between two saw blades mounted on a single arbor. Thickness of the washers regulates the width of the cut. When the saw blades have set teeth, you must allow for the set in determining the spacer thickness. This isn't necessary when using hollow-ground blades.

Industry uses this idea for gang-cutting of duplicate pieces. Of course industrial users are not limited to a single arbor; still it's surprising how much use you can get from the idea with the ordinary table saw.

Two saw blades can speed up the job of kerfing wood for bending. Spacing between the kerfs is set by the thickness of the washers placed between the saw blades on the arbors. Usually it is best to make a special insert for the saw table to reduce open area around the blades. This provides full support for the wood, assures uniform depth of cut, and guards against the work being pulled down into the machine. To make a special insert for your saw table, select plywood or hardboard which equals the thickness of the regular insert. Use the regular insert as a template and then cut and sand the substitute to fit. Lower the saw blades beneath the table surface, place the special insert in the slot, and raise the saw blades with the saw running so the blades cut their own slots. Hold the special insert down firmly with a length of scrap wood until the saw blades are through.

Multiple saw blades make it easy to do decorative cutting. Once the rip fence is



Washers space blades for twin-blade cutting.

Twin-blade Cutting with a Table Saw 2789

▲ *Two blades double the speed with which a series of kerfs can be cut. Note the special insert used to accommodate two blades rather than one and the pencil mark on the insert used to space the cuts accurately.*

▼ *Decorative possiblities of twin-blade cutting are seen in this cupboard door. Use pencil marks to line up ends of cuts, or use stop blocks clamped to the saw table.*

▼ *Both sides of a tenon are cut in one pass. Hollow-ground blades give smooth cut that requires little or no sanding.*

▼ *Twin-blade setup speeds the cutting of several identical strips. For maximum precision, use hollow-ground saw blades.*

set, it's just a matter of lowering the work over the turning saw blades. You can work with stop blocks clamped to the fence to gauge the beginning and end of the cuts, or you can work to pencil guide lines drawn on the work.

If you've ever tried single-blade cutting of checks for a tenon, you'll recognize the value of the twin-blade technique. The distance between blades governs the thickness of the tenon while the spacing from the fence centers the cut in the stock. Any number of tenons can be cut this way on matching pieces of work with the assurance that all will be the same size. Hollow-ground blades will give the smoothest cuts. When making the cut, it's a good idea to use a follow-up block to keep the work vertical and (especially) to keep your fingers away from the blades.

Ever run into the problems involved in making pieces of equal thickness for laminating into a project like a cutting board, or of cutting a lot of strips the same width? Even when working with a jointer it's difficult to smooth the edges and still keep them square to the top surfaces. If the width of the pieces required can be handled within the limits set by the arbor length, twin-blade cutting will remove much of the frustration next time you try jobs like this. Using hollow-ground blades will give the strips a smoother finish.

Give the hollow-ground blades maximum projection above the table to guard against burning.

The two-blade technique is not limited to blades on a vertical plane; you can tilt them, too. A little experimenting along these lines will lead your imagination in many different directions.

Saw blades can even be mounted in two bunches on the arbor. This way you can use multiple blades as dado assemblies to cut the twin grooves, for example, needed for sliding cupboard doors. This eliminates much rip fence re-setting which is needed when cutting the grooves separately and guarantees accuracy. Two blades, each cutting a ⅛-inch kerf, make a perfect ¼-inch groove or dado. When bunching the blades be sure to place the set teeth of one blade opposite the gullets of the next blade. Rabbets as well as grooves or dadoes can be cut in this fashion. Note that the special table insert has a wide slot to accommodate the whole assembly. If the distance between bunched blades is not too much, you can sometimes use a molding head insert to eliminate the chore of making a special one.

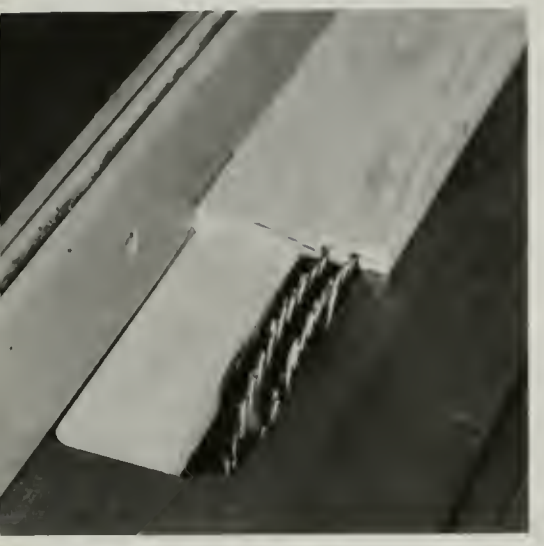
One multiple-blade application for a special operation is the cutting off and making the shoulder cut for a rabbet in one pass. This would be particularly useful when you need a quantity of drawer fronts. If the drawer sides are going to be ¾-inch stock, then the distance from the inside face of the larger blade to the outside face of the small blade will have to be ¾-inch. A second pass with a single blade and with the stock on edge will complete the rabbet cut. If you combine the larger blade with a dado assembly, or a bunch of smaller blades, you could form the entire rabbet when you cut off. The stock must be turned end-to-end after each pass.

Using two blades for cove cutting accomplishes two things—since you are cutting on two lines you get a more flat-bottomed cove than you would with a single blade and, since one blade is following the other, you get a smoother cut. As with all cove cutting, blades with set teeth do the job best—and depth of cut for each pass shouldn't exceed 1/16-inch.

Two blades will cut twin spinals. This idea can be used for decorative cuts (with the spirals left as is) or for outlining a spiral which you will finish by hand. All you have to do is file away the material outlined by the twin-spiral grooves to finish the job. R.J.D.

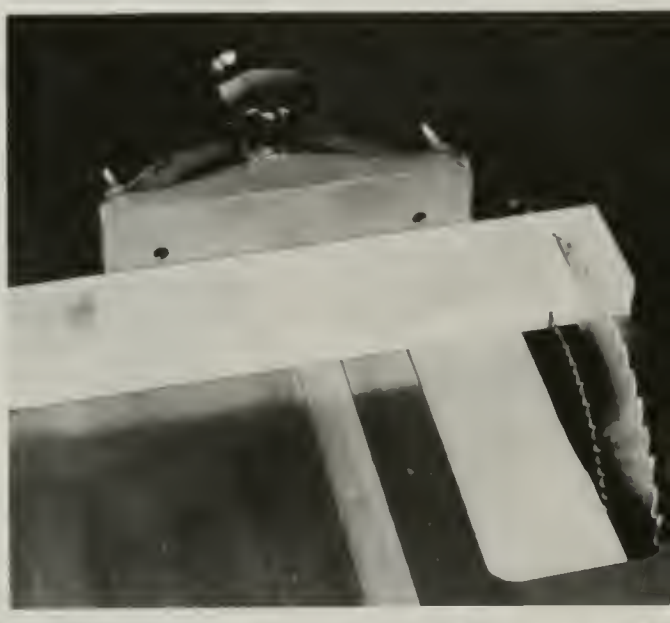
See also: RADIAL ARM SAW; TABLE SAW; TOOLS; WOODWORKING.

Twin-blade Cutting with a Table Saw



Plow grooves for sliding cabinet doors simultaneously by using two pairs of blades. Stagger the teeth of the paired blades.

If you have several drawer fronts to cut and rabbet, use two blades of different size. The larger blade makes the cutoff, while the smaller one cuts the cheek of the rabbet.



Using twin blades for cove cutting allows variations in the shape of the cove. Wide blade separation produces the double effect shown.

Cut a spiral with twin blades. If you wish, you can chisel out the stock between the two spiral grooves to make a more pronounced spiral.

Decorative Cuts with Common Shop Tools

Ordinary drill press and saw attachments can be used to create intricately carved patterns

REPETITIVE PATTERNS easily cut with many conventional shop tools can make conversation pieces out of simple woodworking projects.

What appears to be intricate carving is the work of a fly-cutter. With this and other common tools, you can emboss, scallop, pierce or striate wood and hardboard to create more attractive panels, cabinets, cases, moldings, picture frames and trim of all kinds.

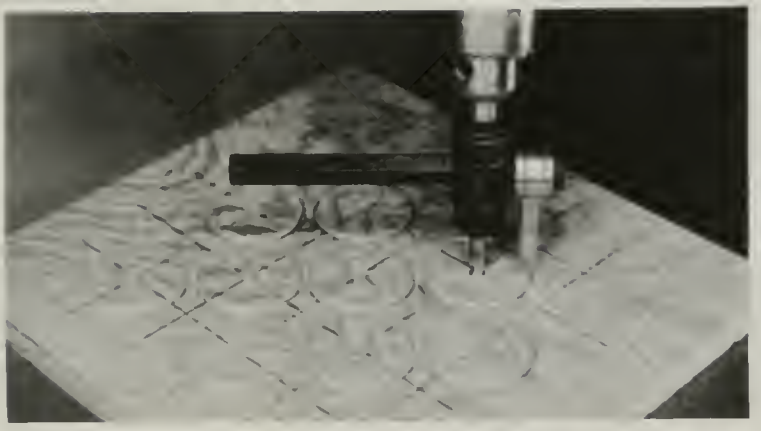
Raised cones. One particular fly-cutter differs from the usual type in that it has a cutting bit that projects from the shaft at a slight angle. Called an *Adjust-A-Drill,* it leaves a raised cone when depth of cut is limited. To increase the deep-carving effect, overlap circles, which will provide faceted areas and cut into the basic cone.

Since this and other type fly-cutters have a pilot drill, a center hole becomes part of your design. You can dress it up with a countersink, or eliminate it altogether by grinding down the drill point so that the only thing cutting is the bit. If you do this, be sure to clamp work securely for each cut. Either way, use a slow drill press speed and feed the cutter steadily into the work.

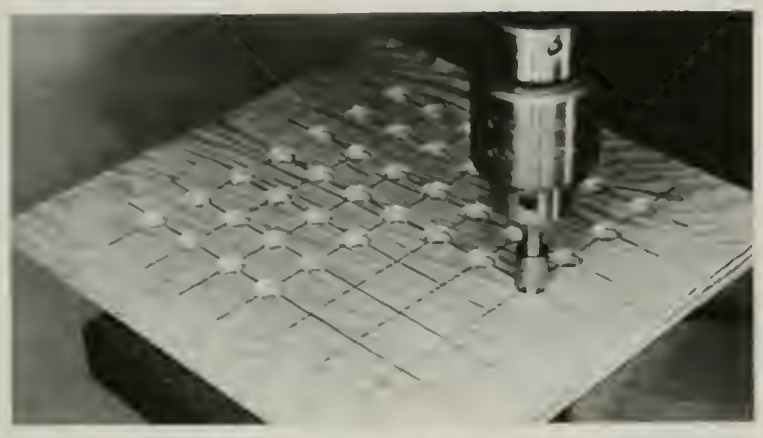
Inverted cones. A single countersink doesn't resemble much, but a series of them produces an intriguing decoration. You can obtain good contrast for the finished job by staining the entire surface, including countersinks, then sanding the surface thoroughly so only the dimples retain the stain. If drill press capacity is too limiting for the work you want to handle, use countersink in a portable electric drill.

Sloped scallops. A multi-spur bit producing a flat-bottomed hole doesn't create very interesting designs on a flat surface, but if you slope the work a bit, the overlapping circles will end up as multi-leveled scallops. As you move the work back, be sure to adjust depth of cut of the bit.

Strip-cut moldings. With the multi-spur bit, you can also cut a section of a hole by drilling close to the edge of stock. By drilling a series of holes and then strip-cutting the work on a table saw, you can produce



Fly-cutter produces interesting patterns of circles with sloped inner walls.



Patterns made of inverted cones are produced with an ordinary countersink.

Four blades fastened simultaneously to this hole cutter produce these concentric rings on particle board.

interesting moldings which need little finishing if you use a hollow-ground saw blade. Work with short or long pieces of stock, depending on ultimate use of the decorated pieces. For more intricate designs, form half-holes on each edge of the stock or change the centerline of alternate holes.

Embossed moldings. Picture frames call for use of the angled-bit fly-cutter, but work only on the stock edges. This requires a fence and a stop that can be set to space the cuts. Select a long straight board and joint one edge. Then drill a series of holes in that edge spaced about one inch apart. You can suit the spacing to your own requirements after you've had a chance to experiment for different effects.

Clamp the fence to the drill press table so the center pilot of the fly-cutter won't hit the work. Then it's a matter of setting depth

Use a table saw to strip-cut lengths of scalloped molding from work that has been edge-drilled with a multi-spur bit. The small cut out pieces can be used as glue-on decorative components.

Fly-cutter embosses a design for molding strip. Slide work along wood fence that takes center bit of the cutter. Develop work from left to right so the cutter will not damage the small triangular portions of the design.

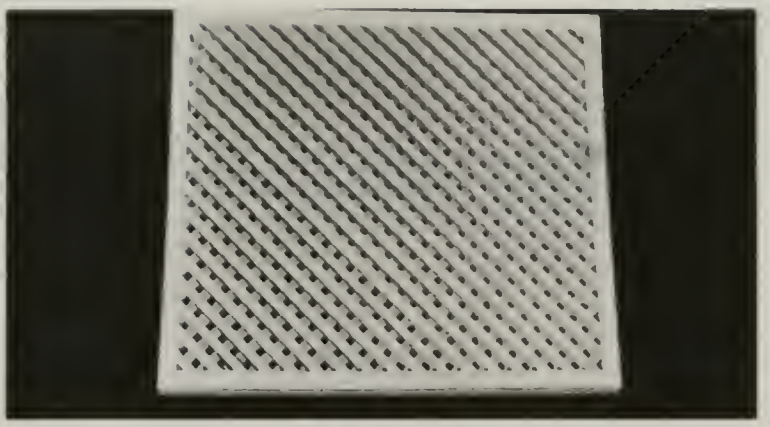
Ordinary saw blade with set teeth does a good striating job on either a radial arm saw or a table saw.

of cut and using a nail in the guide holes to set the spacing between cuts.

Striated surfaces. Even an ordinary saw blade can be utilized to do more than just cut through wood. It's just a question of running the blade back and forth as you move the stock. A blade with set teeth does this job best, with depth of cut very, very light. You can do this faster on a radial arm saw but a table saw will be satisfactory.

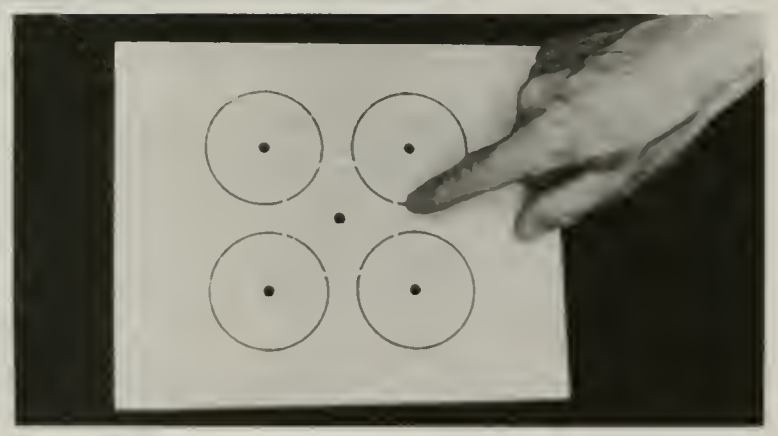
To vary the texture, change depth of cut a little as you work; also change distance between cuts.

Pierced paneling. If you set a saw blade (or a dado assembly, for that matter) to a height little more than half the thickness of the stock, and then make passes on both sides of the work, you will pierce the work where cuts cross and form square holes that combine with the grooves to form a pat-



➤ *Pierced-cut patterns such as this are made by cutting panel from both sides with saw blade or dado head set slightly higher than hall the thickness of the stock. Frame edge was added after the pierce-cutting was completed.*

➤ *Cut large incised scallops on a table sew. Use a rip lence with a clamp as a stop block. The sew cuts its own thickness in the stock. By moving the lence slightly between cuts, making progressively lower cuts, a scalloped effect (top, center cut) can be achieved.*



➤ *All sorts of inlay patterns can be made by cutting circular grooves with a multi-spur hole cutter. Here, the center hole has been inlaid with soft aluminum strips and sanded smooth with the wood surface. Other rings could be filled with colored plastic wood.*

tern. The airy effect achieved is especially good for breaking up a large expanse of panel in a divider or in a sliding door.

Lined with a translucent material such as fiberglass, small panels treated like this can be used as fixtures for atmosphere lighting—indoors or out.

Incised scallops. These can be formed with a sawblade. Set the rip fence so the distance between fence and outside surface of the blade equals thickness of the stock. Butt the work against the screw-clamp stop block, then slowly lower it over the turning blade. For the smoothest cuts, use a hollow-ground blade, but lower the work slowly if you want to avoid burning either the blade or the work.

Inlays. Perfect inlays are easy to prepare if you form the circular grooves with a conventional type fly-cutter. Be sure to set

MATERIALS LIST

Quantity	Size and Description	Purpose
2	5/8" 10"x14" hardboard	top and bottom
2	5/8" 4 1/4"x14" hardboard	box front and back
2	5/8" 1 1/8"x14" hardboard	lid front and back
2	5/8" 4 1/4"x9 3/4" hardboard	box sides
2	5/8" 1 1/8"x9 3/4" hardboard	lid sides
as needed	5/8" #3 flat head wood screws	

NOTE: Also need butt hinges, finishing nails and glue.

the bit so it will contact the work before the center pilot. If you clamp the work and keep the drill press speed slow, the grooves formed will be uniform and smooth.

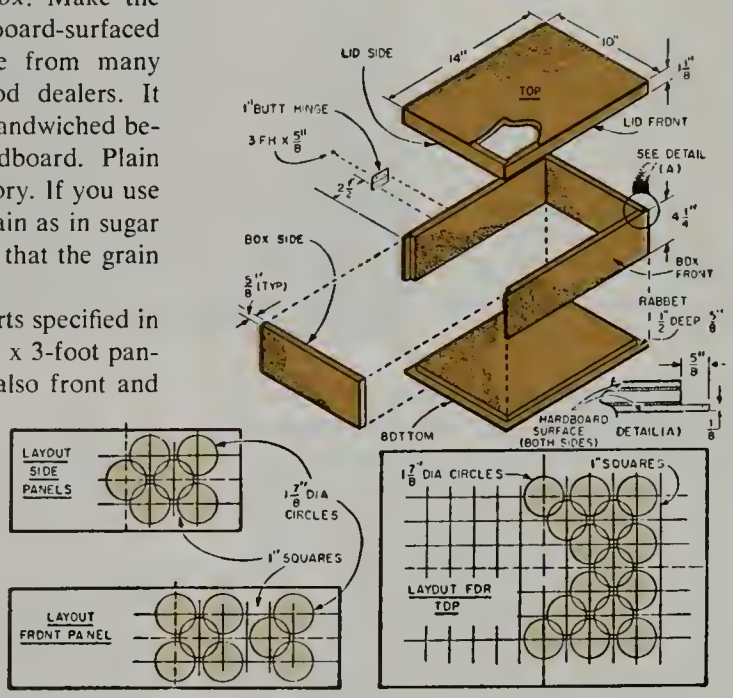
Fill grooves with a contrasting plastic wood, let this dry hard and then sand the surface for a perfect inlay. You might also fill grooves with copper wire. Form a shallow groove so you can force the wire in place; then sand off the surplus.

If you want an irregular line instead of a perfect circle, substitute a router for the fly-cutter.

Building the decorative box. Make the box out of 5/8-inch hard-board-surfaced plywood, which is available from many building supply and plywood dealers. It comprises 3/8-inch plywood sandwiched between 1/8-inch plies of hardboard. Plain hardboards are also satisfactory. If you use wood, it should be free of grain as in sugar pine or as dense as maple so that the grain will not spoil the fine cutting.

You can cut all the box parts specified in the Materials List from one 2 x 3-foot panel. Rabbet top and bottom, also front and back pieces of box and lid. Rule off top, front and side pieces in 1-inch squares to establish pilot hole locations for the fly-cutter and make the decorative cuts. Back of box can be left plain or duplicate the front pattern. Assemble box with glue and 6*d* finishing nails. Set nail heads and fill holes with wood putty colored to the shade of the wood. R.J.D.

See also: DRILL ATTACHMENTS, POWER; DRILL PRESS; INLAY WOODWORKING; POWER TOOLS; RADIAL ARM SAW; TABLE SAW; TOOLS; WOODWORKING.



Use this plan for making a decorative box.

Jointing with Wood Shapers

How to miter, rabbet and groove with a drill press, shaper, or radial arm saw

SHAPING IS MORE THAN a matter of cutting moldings on table tops. As a matter of fact, a wood shaper is a versatile machine capable of turning out a wide variety of operations. However, a drill press, combination machine or a radial saw will substitute efficiently, if a shaper is not at hand.

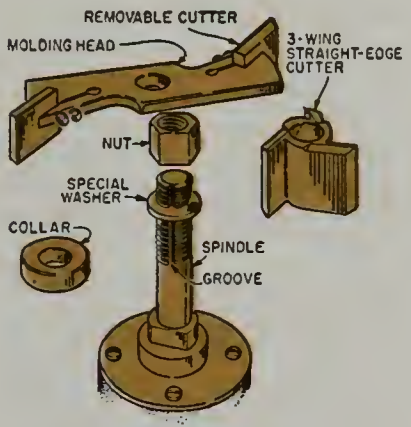
The standard small wood shaper comprises a table with a hole in it through which passes a vertical threaded spindle on which cutters are mounted. The projection of the spindle above the table is changed on some machines by raising the spindle, on others by varying the height of the table. Spindle speeds of 8,000 to 10,000 rpm make for smooth and fast cutting. An adjustable fence is provided for straight work, but for curved or irregular pieces, fixtures are used, or the unshaped piece is guided freehand against a collar on the spindle. The collar follows the curves and governs the depth of cut. A miter gage is used to guide the work when ends of boards are shaped.

Three-winged shaper cutters are most often used in small shops, although a circular saw molding head is often used with combination and radial saws. The inexpensive type is made of carbon steel, but better service can be obtained from those made of high-speed steel.

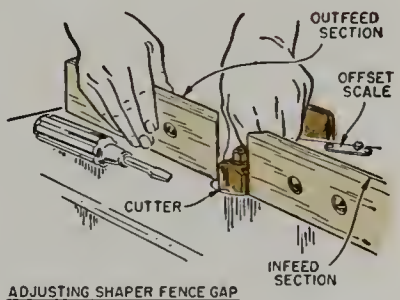
Drill presses and combination machines mount cutters on threaded adaptors, turning them at a top speed of about 5,000 rpm. A radial saw is limited to the motor speed of 3450 rpm. Molding cutters, which are often used, are of a larger diameter than three-winged cutters, and have an actual knife cutting-edge speed about the same as a shaper cutter turning at 8,000 to 10,000 rpm. However, three-wing cutters are effective with these machines.

So effective is the wood shaper as a jointer that it displaces a standard jointer in many small commercial shops. To set up for jointing, mount a straight-edge cutter on the spindle having edges slightly longer than the thickness of the board to be milled. The practice is to build up most of the extra spindle length with collars, stiffening the spindle and reducing the distance the nut must be run on. Be sure to use the special washer, which has a projecting lug to engage with the spindle groove and keep the nut from working loose. Face the cutting edges of the cutter in the direction of rotation. If the shaper has a reversing switch,

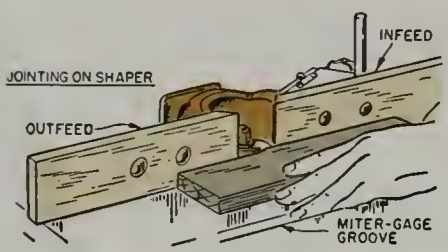
the feed can be from either right or left according to inclination, or to favor grain direction when keeping the working face against the table of the machine. If the spindle turns in only one direction, the work can be fed only against it. For safety, project the cutter only slightly above the work, and the use hold-downs, push sticks and other safety devices wherever your fingers must approach close to the cutter. Pieces 6 inches or shorter should be held solidly in a fixture for any shaping.



SHAPER SPINDLE AND JOINTING CUTTERS



ADJUSTING SHAPER FENCE GAP



As with a jointer, a depth of cut of ⅛-inch will straighten the average board. Offset the fence sections to the depth of cut and bolt the fence to the table with the outfeed section aligned with the cutter edge, a position found by holding a straightedge against the outfeed face and turning the cutter. The edge should touch the straightedge lightly. If the outfeed section can be advanced ahead of the other, bolt down the fence with the cutter even with the infeed face, joint about 6 or 8 inches of a piece of wood and advance the outfeed section to touch the jointed part. Lock the assembly. Loosen the screws in the wood facings and bring the facings together until there is only enough gap to clear the cutter.

When jointing a board, slide the edge against the infeed fence first, holding it firmly as the cut starts. Keep your hands as far as possible from the cutters. By sliding your fingers along the edge of the table, or in the groove, the chance of your fingers sliding toward the fence if the piece is thrown off, is greatly reduced. Feed the piece at a uniform speed that the shaper will easily take. Too slow feeding may burn the wood; too fast will leave cross-ribs on the edge of the piece.

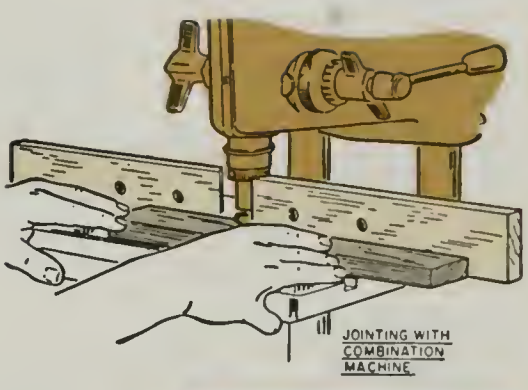
The only difference in jointing with a drill press is that the spindle is above the work. Shaping fences are made for this machine. Occasionally the drill press head is removed from the column and replaced upside down to put the spindle underneath. The table is then placed above the head. The fence for a combination machine duplicates the functions of a shaper fence and the off-feed section is set forward against the end of the partly-jointed piece to give support to the cut-away part of the edge.

The fence for the radial saw is normally a continuous straight strip clamped between the table boards. For jointing use pieces, with a gap for the cutter. Add to this a piece of ⅛-inch hardboard with the off-feed section reduced in width so that it is

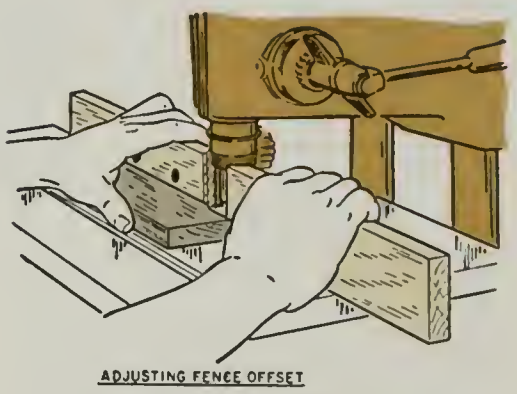
flush with the table at the infeed end. A molding head, because of its large sweep, does a clean jointing job. Set the motor in the vertical position, lower the arm until the cutters just clear the table, and place a piece of ¼-inch plywood or hardboard under the work to raise it enough for complete cutting of the edge. The cutters must be accurately aligned with the outfeed fence. When coming to the end of a cut, keep your fingers away from cutters by using push sticks.

Jointing parallel sides on one piece of wood to a predetermined width, or several to the same width, can be handled quickly and accurately by placing the workpiece between the cutter and the fence. Joint one edge of each and then clamp a strip of wood to the shaper table at the required distance from the cutter. While it is possible to slide a board between the fence and cutter holding it firmly against the fence with your hands, it is much better to clamp a wooden spring to the table, with the spring finger ends bearing against the edge to be jointed. Place a piece of cardboard between the spring and the table to provide clearance for the spring fingers. A piece of plywood with the end cut into a ring and clamped over the cutter is an excellent safety device. The setup for a drill press is essentially the same as for a shaper. For wide work, clamp on an auxiliary table wide enough to carry the fence.

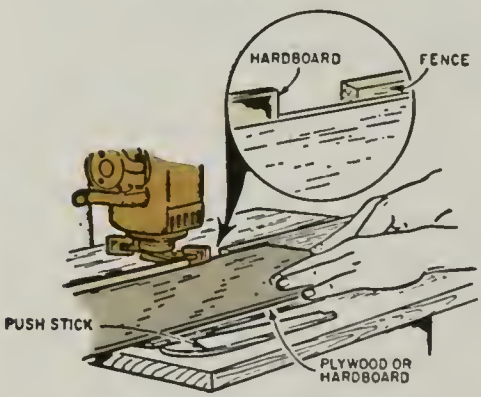
Cutting an offset or recessed edge on a piece of wood becomes a fairly simple operation on a wood shaper. If the width is reduced at the forward end, the piece is pushed forward over the cutter as far as a predetermined pencil mark on the piece, fence or table indicating the limit of travel. A stop block clamped to the fence at the



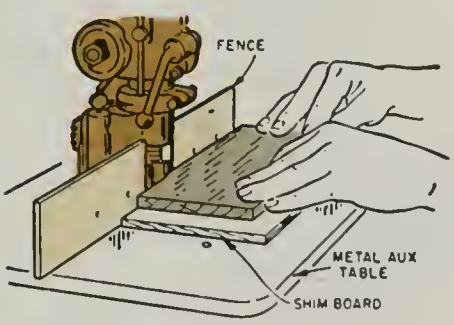
JOINTING WITH COMBINATION MACHINE



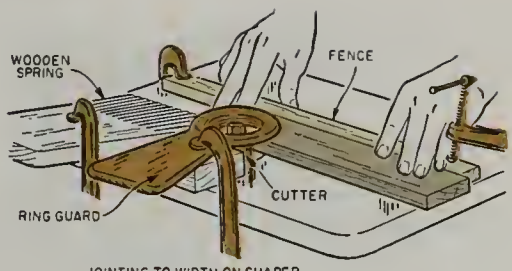
ADJUSTING FENCE OFFSET



JOINTING WITH RADIAL SAW (GUARD REMOVED TO SHOW OPERATION)



JOINTING WITH DRILL PRESS



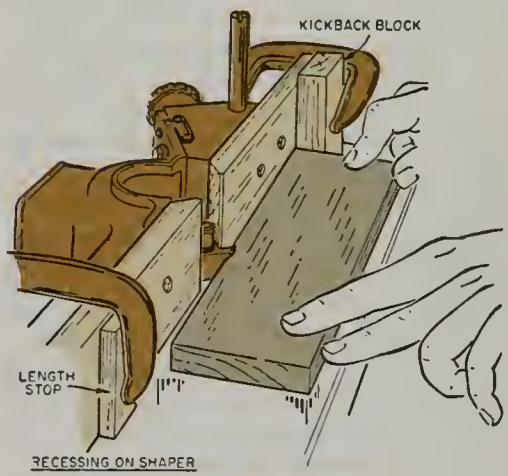
JOINTING TO WIDTH ON SHAPER

desired point can also be used. If the cut or recess is to be made at the near end, clamp a kick-back block to the fence or table and butt the near end of the workpiece against the block. Then slowly swing the work against the cutter. In this case both faces of the fence are aligned. Push the work forward to the end, being careful to maintain pressure against the outfeed section. The recess may be "stopped" at both ends with stop blocks. Since the cutter leaves a rounded corner, a saw must be used to make the corner square if desired.

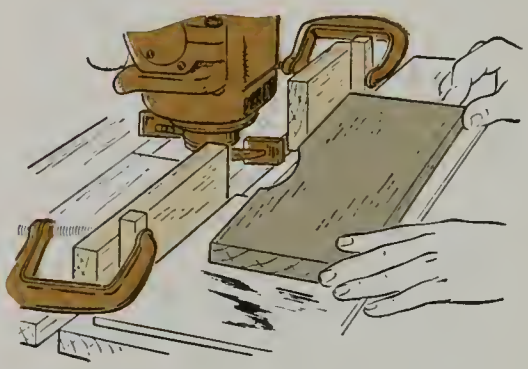
Chamfering is commonly done with a diamond-point or other diagonal-edged cutter. Mount the cutter on the spindle so that the chamfer or bevel will be cut on the underside of the work. Set the fence faces even and adjust them and the spindle height so that the cut will be taken close to the center of the cutter blades. If the work must be chamfered with the cutter positioned above the work, make full use of hold-downs not only for safety, but because the piece will be gouged if it accidentally lifts from the table. Stopped chamfers are made in the same way as stopped recesses.

Mitering of thin stock is similar to cutting chamfers. However, since the entire edge of the workpiece is removed, it may be cut back somewhat necessitating an offset of the fence faces as for jointing. A convenient setup for beveling with a combination machine is to tilt the table and run the piece against a straight-edge cutter as in jointing. The operation amounts to bevel jointing to width. The tendency of the board to settle down against the fence is helped by the use of a wooden spring. To miter the edge of a board with a radial saw, merely tilt the motor to the desired angle. Carefully set the arm height and cutter position relative to the fence so that a full miter without cutting back on the edge of the board will be produced. Place a thin board underneath the work to elevate it so that the cutter can be set just above the table top. When possible, mount the saw guard to shield the cutters from the back.

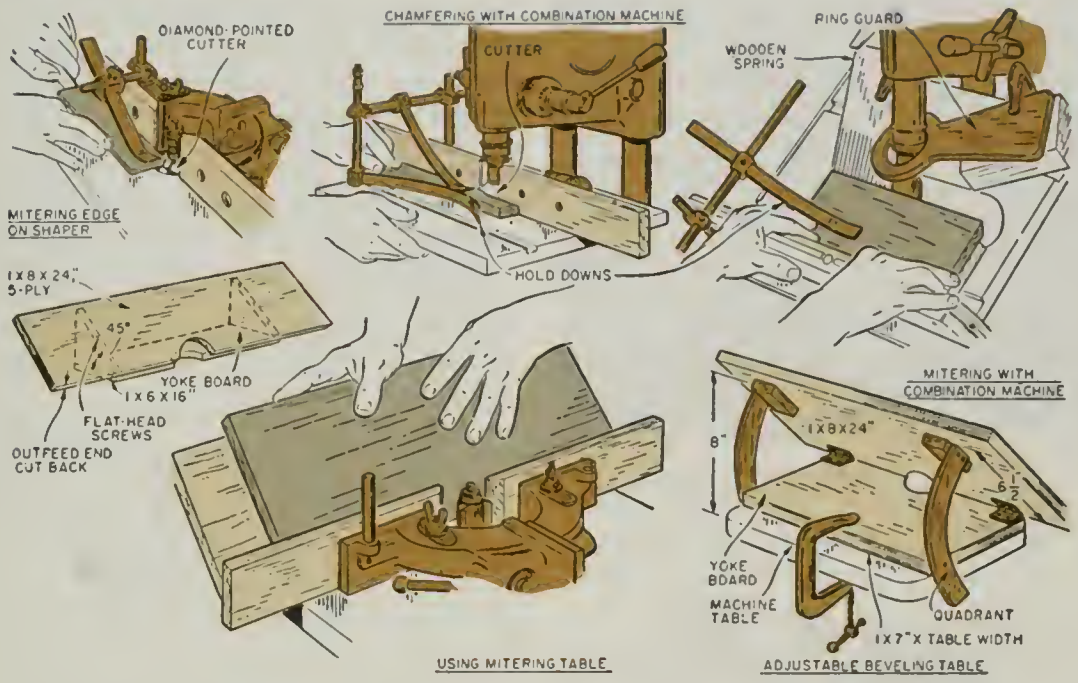
Since a shaper table cannot be tilted, an auxiliary table built at an angle of 45° is useful for edge mitering Use it in conjunction with the fence. The outfeed end of the table is cut back so that the fence can be offset in case the edge of the board is cut



RECESSING ON SHAPER



RECESSING WITH RADIAL SAW



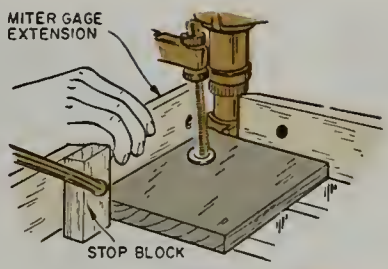
back a little in mitering. The two triangular brackets are united with a yoke board beneath, which can be clamped to the shaper or drill press table. With this accessory, mitering can be done as easily as jointing.

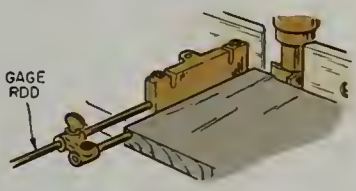
Since beveling is nothing but mitering at an odd angle, the operations are the same. An auxiliary table of the adjustable type can be set for beveling at any angle. Make the yoke board the same length as the machine table and hinge it to the auxiliary top piece. Cut the quadrants from ⅜ or ½-inch plywood. In use, the quadrants and yoke are clamped to the machine table. Degree index marks on the quadrants would facilitate setting the table to the required angle. Give the table two coats of resin sealer.

Rabbeting is a jointer operation with the faces of the fence in alignment. With the shaper, project the straightedge cutter above the table measuring with a try-square and lock. Adjust the fence for the required depth of cut. Then feed the piece past. Wide boards can be handled without hold-downs or push sticks. If, when using a drill press, the cutter must be above the work, remember to guard it, and keep in mind that any lifting of the work will damage the cut. When using push sticks, avoid pushing the near edge at the end of a cut into the gap in the fence, which would deepen the rabbet.

The setup for rabbeting with a radial saw makes use of a combination of a shim board of the right thickness and height adjustment of the motor to place the top of the cutter where needed. When the distance from the bottom of the rabbet to the far edge is important, a setup as for jointing to width is useful. Again the wooden spring to prevent the work from working out against the cutter is useful. The setup shown here for the combination machine works equally well with other machines.

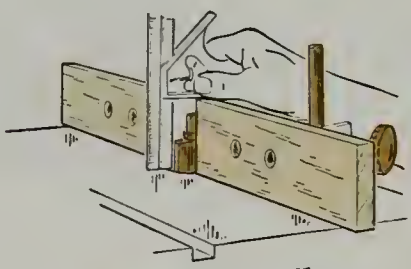
Wide rabbets in the face of a board are made with the face run against the fence and cutter. If the width of the cut to be made is greater than the cutter edge, take additional cuts with the spindle elevated.



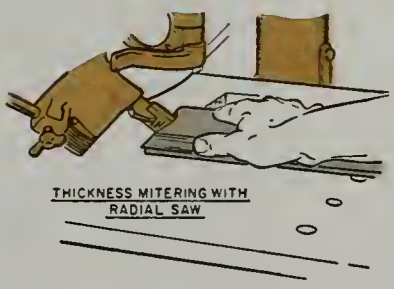


JOINTING END

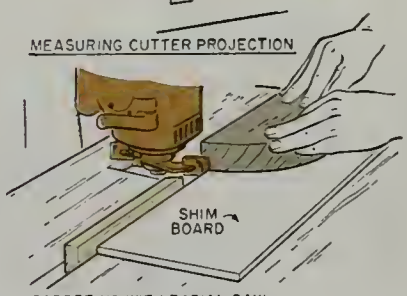
To avoid pushing the rabbeted portion against the fence, cut a filler strip to go between the rabbet and fence, or raise the wooden spring to the height of solid wood. For an end rabbet a high auxiliary fence clamped to the shaper fence will help to keep the workpiece upright. To prevent splintering of the following edge, place a scrap piece against the rear edge of the workpiece and run the rabbet part way into the scrap. Grooving is simply a modification of rabbeting, a narrow cutter raised above



MEASURING CUTTER PROJECTION

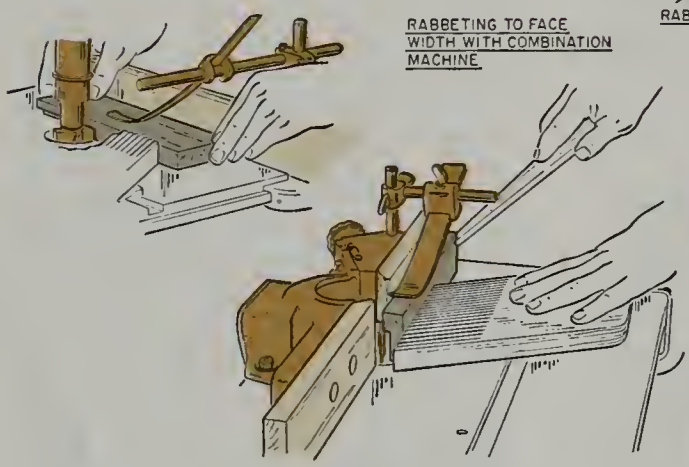


THICKNESS MITERING WITH RADIAL SAW

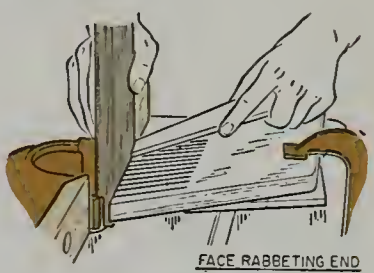


RABBETING WITH RADIAL SAW

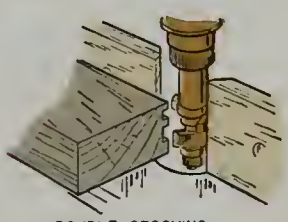
RABBETING TO FACE WIDTH WITH COMBINATION MACHINE



FACE RABBETING WITH SHAPER



FACE RABBETING END



DOUBLE-GROOVING

the table doing the work. Two or three cutters may be ganged with collars separating them for multiple grooving. Hardwood washers of special thickness can be made, with paper washers added to get exact dimensions.

Joint the end grain of a wide board the same as you would an edge. Support a narrow piece against the miter gage, feeding it across the cutter. To prevent the blades from driving the piece back, clamp a stop block against the end, or if the work is short, use the rod gage. Joint the end-grain edge first and then the with-grain edge, or put a following block between the miter gage head or extension and workpiece to prevent chipping.

While the shaper fence isn't essential, it is useful for establishing the depth of cut, and serves as a cutter guard. The miter gage can be swiveled for jointing ends at angles other than 90° with the edges.

A jig can be made for mitering ends through the thickness of a piece of work with a shaper. Cut a piece of 4 x 4-inch stock to the angle desired and screwfasten a piece of 1 x 4-inch lumber to the angle cut face of the 4 x 4-inch stock. The piece to be mitered is then clamped to this sloping 1 x 4-inch piece, and the jig positioned and clamped to the miter gage extension so that the shaper cutter will cut across the end of the workpiece. The operator's hands are well back and protected. However, the addition of the fence is useful to locate the end of the piece to be mitered and as a guard for the cutter. Since shrinkage of the 4 x 4-inch member will alter the angle of the jig, remove the 1 x 4-inch piece if it is out of true and dress the mitered face of the 4 x 4-inch base to correct it.

Thickness mitering with the radial saw is accomplished by setting the motor on an angle as for mitering with a saw, a molding head with cutters being substituted for the saw blade. Hold the workpiece against the fence, clamp a stop block to the fence at the

Using a drill press set up as a jointer for truing the edge of a piece of stock. Clamps from a pair of roller skates are used to control infeed and outfeed fences. They are adjusted with a skate key.

end of the workpiece to keep it from slipping away from the cutters and place a shim strip beneath the work so that the cutter corners will not score the table top. The fence, if brought up to the line of cut, will prevent back splintering of the work, if it is held tightly against it. Grooving is just as easy on mitered edges and ends as on square ends. Just set up as for mitering and use a cutter of the groove width desired. Tonguing is the reverse of grooving. Use a couple of spaced cutters to make rabbets above and below, or set up a single cutter and cut rabbets on each side individually.

Matched sets of tongue and groove knives for molding head cutters are available. These sets assure perfect matching of the tongue and grooved edges cut on two boards. Glue-joint knives for molding head cutters are shaped to cut shallow tongue and grooves. Only one set of knives is required because design is such that two boards cut with the same set will match.

M.E.

See also: DRILL PRESS; PICTURE FRAMING; POWER TOOLS; RADIAL ARM SAW; ROUTER; WOODWORKING.

Shaping and Cutting Large Workpieces

Use these tips to make accurate cuts in long pieces of stock

Build a roller support, like this one with adjustable height, to support long pieces being run past a saw, shaper or jointer. If storage is a problem, pivot the rear leg so the unit can hang flat on a wall.

HANDLING LONG WORKPIECES is a problem basic to many woodworking operations, and must be reckoned with. Few small shops have room for permanently attached extension tables. A simple way to support a long board is to support the outboard end on a bench, shimming it up with strips of wood, if necessary.

Much handier is a roller support having a 12-inch long roller supported on a slotted column capable of being raised or lowered a few inches to match the height of the machine. By hinging the rear leg of the stand to fold flat, the stand can be hung on a wall out of the way when not in use.

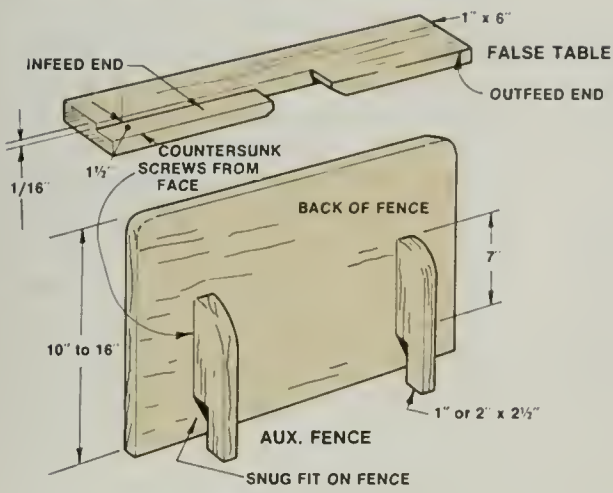
Except for short work, an auxiliary fence bolted to the head of a miter gauge is needed. For most jobs one 18 inches long is good, although it may well be longer and heavier for large work. A cure for the tendency of pieces being mitered to creep into the cutter is to drive two or three brads into the face of the fence, and file the heads to points. The slightly projecting points prick into the work, anchoring it.

A molding head mounted on a table saw is effective for jointing, rabbeting, molding, etc. A special dado insert is placed in the table. It may be set vertical or tilted, and the position of the fence with reference to it, varying the profile of a molding as desired. In some cases, the work can lie flat on the table.

Two- and three-knife slotted molding heads are available into which a wide variety of cutter knife shapes may be inserted and locked in place. Two-blade, solid shaper cutters are also available in a variety of molding shapes.

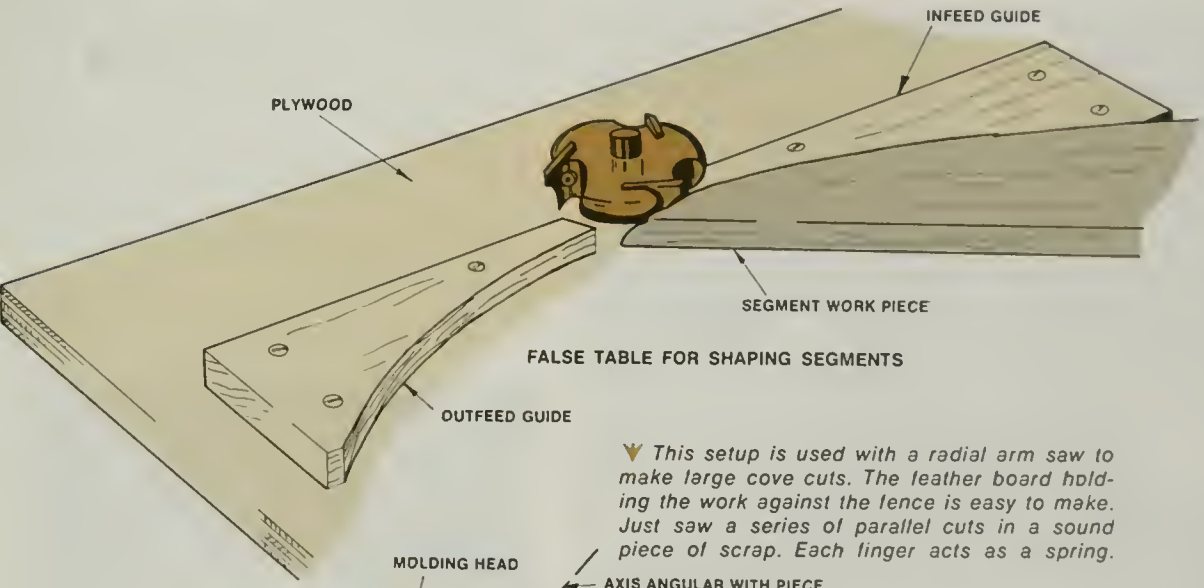
A piece worked with the edge against the table must be supported by a fence, and if it is more than 6 inches wide, it needs more backing than is given by the stock machine fence. This can be supplied by

Shaping and Cutting Large Workpieces 2805



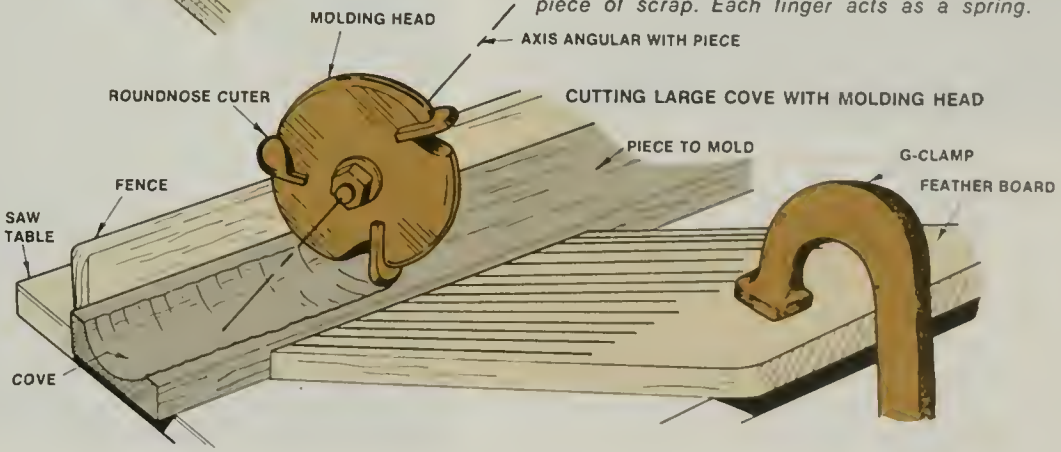
◀ *False table is used with molding cutter on thin stock. Infeed is lower than outfeed, so the stock rests in a natural position at each side. This keeps the free end from rocking against the table and causing the cut to be flawed. The auxiliary fence is used for steadying work in a vertical position.*

▼ *Make a false table for cutting rounded segments such as this. Design table and guides to fit the particular job you are working on.*



FALSE TABLE FOR SHAPING SEGMENTS

▼ *This setup is used with a radial arm saw to make large cove cuts. The feather board holding the work against the fence is easy to make. Just saw a series of parallel cuts in a sound piece of scrap. Each finger acts as a spring.*



CUTTING LARGE COVE WITH MOLDING HEAD

bolting a wide board to the machine fence, having the bolt-heads sunk flush. Better, add wooden hooks to the back to fit snugly over the saw fence, so that it can be slipped on or off as needed, and hung out of the way when not in use.

Narrow pieces to be shaped on the ends need support on an additional sliding fence.

When the work is to be jointed, or the entire edge is molded, paring away a portion of the edge, some provision should be made to support the off-feed end of the work which has been reduced, or it will rock down against the fence, making a joggle in the molding. A cure for this is a false table, which is notched to admit the molding head. Rabbet the in-feed end 1/16-inch deep. Adjust the fence to graze the cutters and clamp the false tables at the ends, the notched and rabbeted edge against the fence. If the depth of cut for jointing, or the highest point of the molding, is set accurately to 1/16-inch, the work should slide smoothly from in-feed to out-feed without noticable offset in the edge.

A narrow workpiece to be shaped on the end can be clamped to the swinging arm on the sliding fence, locking it with regard to the cutter and making the false table unnecessary.

Accurately feeding and guiding a large and wide piece of stock or a long and narrow board when shaping the edge is a lot easier if the stock can be handled in the horizontal position. The large flat work table of the radial arm saw and the fact that the arbor spindle with molding head cutter can be locked in the vertical position makes this a good tool for these large unwieldy jobs.

See also: JIGS; POWER TOOLS; RADIAL ARM SAW; TABLE SAW; TOOLS; WOODWORKING.

▲ *To miter the end of a long piece of stock, add length of miter head with a piece of scrap. Drive three brads into the scrap as shown and file each head to a point. This will keep the workpiece from creeping as you cut.*

➤ *Use an auxiliary fence when cutting dadoes or rabbets in the ends of pieces.*

How to Select a Trailer Hitch

Safe towing depends on the match between the hitch you use and the weight and type of trailer you are hauling

NO MATTER WHAT your choice of trailers happens to be, you are going to be depending upon one very important item: your trailer hitch. It is the connecting link between your car or your pickup truck and what you are towing. Proper choice of your hitch is of utmost importance if you are going to get the enjoyment and peace of mind out of your travels that you have every right to expect. You will be wise to conduct your own research into the matter because the wrong selection now is only going to mean trouble later on.

How much weight? Hitches are rated by the amount of weight they are designed to carry. That's no problem, you think. Your dealer has told you what weight you will be towing. Then again, however, he may only be talking about the empty weight of the vehicle. Remember that empty weight can be several hundred pounds lighter than the actual weight of your trailer after it is loaded for travel. You can arrive at the true figure by weighing everything you intend to carry and adding it to the trailer weight. Better yet, you can drive your trailer, fully loaded, onto a scale and know for certain what you are towing.

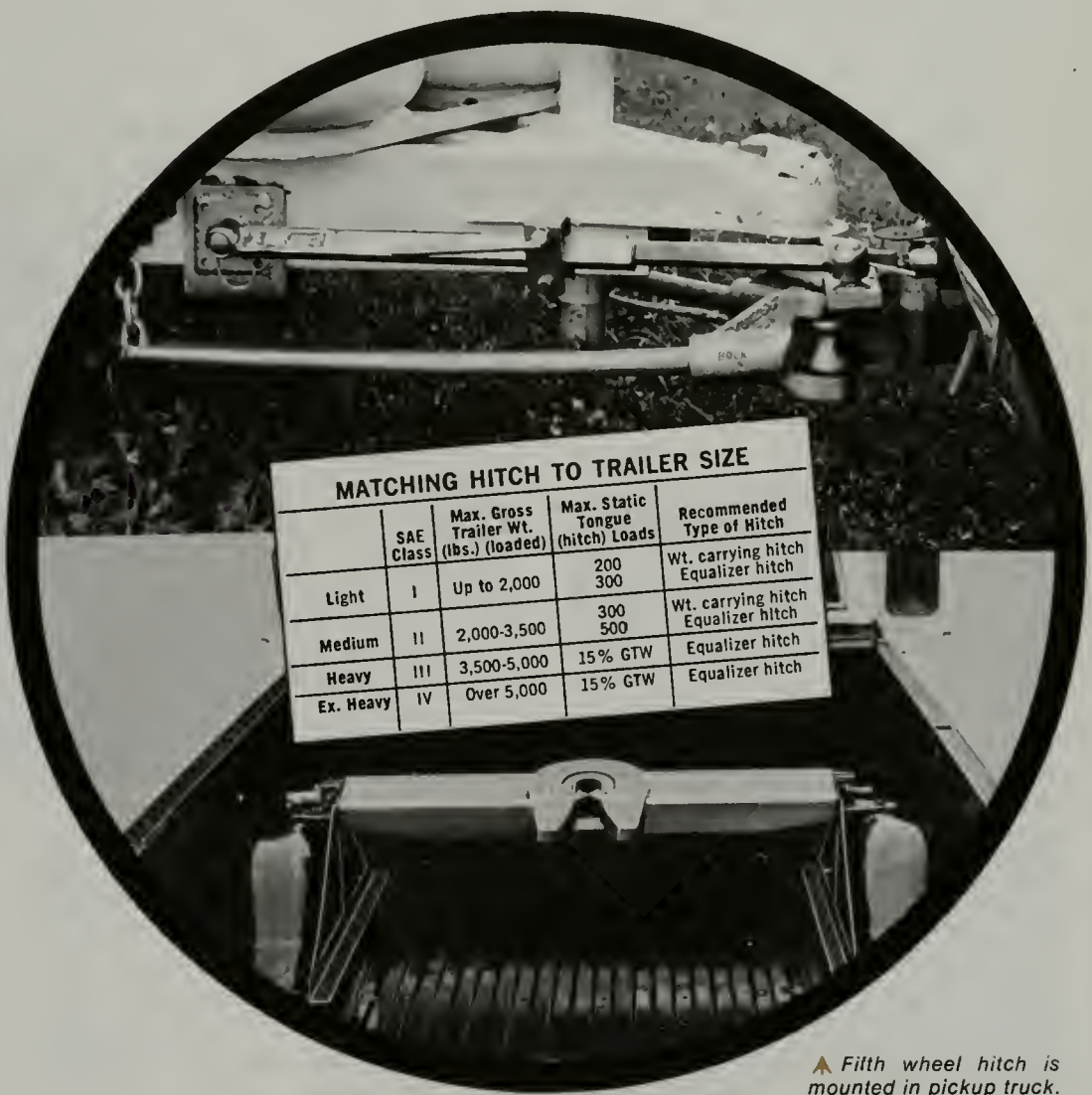
If you are involved with one of the larger travel trailers and expect to carry a considerable amount of weight in it, plus a full car trunk and five or six passengers, you will want to look into what are known as equalizing hitches. This type of hitch will "pick up" the rear of the car and give you much better control of your car-trailer combination. Likewise, if the vehicle you are towing is longer than 20 feet, you will want to check on hitches that are equipped with sway control. Such hitches are worth every cent they cost in terms of controlling your car and vehicle on the highway and in giving you smooth, safe operation.

Know your dealer. When purchasing a trailer and hitch you are obviously going to have to depend upon the dealer with whom you do business. Check around to be sure he is reliable and experienced. Your friends may have had varying experiences with different dealers and you can profit from what they tell you. If you're still in doubt, check with your Better Business

trailers: see campers

Bureau. Then, when you are thoroughly satisfied that you are doing business with the right dealer, be sure he completely explains how to hook up your trailer and how to maintain both trailer and hitch. It is recommended that you test-drive your car with trailer attached to be sure you understand the entire operation. You should feel comfortable and entirely at ease in this situation. If not, learn why you aren't. A good dealer will be glad to answer all your questions. He wants you to enjoy your purchase and recommend him to others, if he is a responsible businessman.

An equalizing hitch, a good idea for any trailer, is essential for Class III and IV trailers. Equalizing hitches transmit some of the trailer weight to the front wheels of the tow vehicle.



MATCHING HITCH TO TRAILER SIZE

	SAE Class	Max. Gross Trailer Wt. (lbs.) (loaded)	Max. Static Tongue (hitch) Loads	Recommended Type of Hitch
Light	I	Up to 2,000	200 300	Wt. carrying hitch Equalizer hitch
Medium	II	2,000-3,500	300 500	Wt. carrying hitch Equalizer hitch
Heavy	III	3,500-5,000	15% GTW	Equalizer hitch
Ex. Heavy	IV	Over 5,000	15% GTW	Equalizer hitch

Fifth wheel hitch is mounted in pickup truck.

How to Select a Trailer Hitch

Bolt-on vs. welded. Hitches are installed beneath the frame of a car by either welding them or attaching them with bolts. Either method is acceptable. The bolt-on hitch, of course, is easier to remove for installation on another car.

Approximately 90% of all the trailer hitches manufactured in the United States are produced by the manufacturers whose names and addresses are listed in Where To Find It. This group forms the Trailer Hitch Manufacturers Association and sets about creating manufacturing standards that would meet the growing amount of legislation being formulated in various parts of the country. The association was joined in this effort by the Recreational Vehicle Institute.

The combined action of the THMA and RVI are important to you as a trailer and trailer hitch purchaser. Now, when you work with a dealer associated with either of these groups you can expect to come up with dependable, safe equipment that will also conform to laws now in effect or likely to be passed later on.

Pickups and fifth-wheelers. There is a different type of hitch application involving a pickup truck (usually a three-quarter or one-ton model) and what is known as a fifth-wheel trailer. The principle used is very similar to that used by the big tractor and semi combinations you have been seeing on the road for years. It started out as a commercial application but, before long, the recreational vehicle industry saw the possibilities of this combination. More and more of them are producing fifth-wheel RVs to be used with pickups, and the combination has excellent handling characteristics. It is installed inside the pickup body directly above the rear axle.

Each approach, the car with a hitch under the frame and the pickup truck with a hitch installed inside the body above the rear axle, has its own advantages. It all adds up as to which is the best approach for you.

▲ *Hitches are installed beneath the frame of a car by either welding or with bolts.*

As said earlier, do as much research on your own as possible—and work with the most reliable dealer you can find.

See also: BOATING; CAMPERS; MOBILE HOMES; SAFETY, BOAT; TRAILERS, BOAT.

WHERE TO FIND IT

Some major trailer hitch manufacturers include Acar Industries, 4563 Industrial Parkway, Willoughby, Ohio 44094; Acme Products Co., Inc., 7300 East 17th St., Kansas City, Missouri 64126; Big Boy Products, Inc., PO Box 223, Warsaw, Indiana 46580; Bock Industries, Inc., 2704 South Nappanee St., Elkhart, Indiana 46514; Classic Manufacturing, Inc., US 12 and Klinger Lake Road, Sturgis, Michigan 49091; Draw-Tite Div., Hoover Ball & Bearing Co., PO Box 291, Belleville, Michigan 48111; Eaz-Lift Spring Corp., 10612 Keswick St., Sun Valley, California 91352; Equal-I-Zer Sales Corp., PO Box 15394, Salt Lake City, Utah 84115; Fool Products, PO Box 9172, Lansing, Michigan 48910; Ideal Manufacturing Co., 1107 South 7th St., Oskaloosa, Iowa 52577; Pilot, Inc., PO Box 40, Battle Creek, Michigan 49016; Reese Products, Inc., 4013 Cassopolis St., Box 940, Elkhart, Indiana 46914; Unicroft, 11619 Pacific Highway South, Tacoma, Washington 98499; Valley Tow-Rite, Inc., 27 East Vine St., Lodi California 95241 Write to them for further information.

Tips for Trailer Towing

You can tow a big house trailer or a small camper without difficulty, if you have the correct equipment and use these tips for trailer towing

DON'T LET THE SIZE of large trailers intimidate you. It's no big deal to tow a travel trailer or drive a home-on-wheels. Thanks to power steering, power brakes, and automatic transmission, you don't have to make like a truck driver. Bucket seats and carpeting in truck cabs and motor-homes, plus optional stereo music and air conditioning, contribute to luxurious driving comfort. And the anti-sway devices and new bolt-on frame automotive hitches, for more uniform towing capabilities, make towing safer and simpler too.

If you make sure your new recreational vehicle is properly equipped and spend a little time to familiarize yourself with its handling characteristics, you'll find yourself taking to the highway in it as quickly as you would the family car. RVs are family fun machines and easily driven by either men or women.

Some types of recreational vehicles are simpler to drive or tow than others. For the more timid start out with a mini-home, pickup truck camper or a van conversion. Next in ease of handling would be the fifth wheel trailer chassis mount pickup, and the motor home, and finally the conventional trailer.

The travel trailer has been around the longest and has outsold all other trailers for years. One reason, of course, is that you can unhitch the car to take the whole family sightseeing once the trailer is parked in camp.

Side-view mirrors are one of the most important items the trailer owner will buy. Do not economize here, but rather buy good quality and sturdily braced mirrors that won't vibrate in travel. Purchase hinged mirrors so they will tend to give rather than smash, if you should brush against something in travel. And you definitely should have a convex mirror at the bottom of each side-view mirror for wide-angle viewing.

The convex mirror can be a trailer driver's best friend. It helps you eliminate the blind spot just behind you when you are at the wheel. It allows you to know exactly where the edge of the road is at all times, and with the help of a convex mirror, you can park a motor home or pickup camper as easily as you do a passenger car, with a little practice.

The travel trailer owner should have a good equalizing hitch that distributes the weight to all four wheels of the tow vehicle. Then add an anti-sway device to eliminate sway and yaw, safety chains, and a break-away switch to keep the trailer from running wild in case the hitch disengages.

You should know what to do just in case your trailer begins to fishtail (swing from side to side). This could happen if by chance you drop a wheel off the road, hit a bad bump going too fast, or experience backpressure from passing a large semi-trailer truck at too high a rate of speed. If

you will quickly accelerate your tow car and at the same time apply hard pressure to the trailer braking device, you can bring your trailer under control without mishap in most cases. But you must act immediately, so know your equipment.

Everyone should have a pre-flight check list, whether you keep it in your head or write it down and keep it handy. Before traveling each day you should check your tire pressure. Be sure you buy an accurate gage for this purpose. An underinflated tire will overheat and you can anticipate a blowout, especially in hot weather. Underinflated tires also may cause handling problems. Or, conversely, by adding a few extra pounds of air to the rear tires of a pickup for example, you can improve steering control up front; add extra air to your tow vehicle's rear tires and you can eliminate fishtailing.

Wheel lugs should be checked periodically at a gas station. Wheel bearings need repacking with grease each year. Boat trailers may require it more often, trailers too if you do a lot of traveling. Also, if you are towing a boat on a trailer, check the winch and/or tiedowns that hold the boat whenever you stop at rest areas or for gasoline.

Get in the habit of walking around your rig each morning before takeoff. This way you won't leave any camp gear behind and you'll remember to put up the door step, unhook all utilities, store sewer hose and/or stabilizers, close roof vents, and latch all compartments tightly. Inside your trailer make sure the refrigerator pin is in place that keeps the door from opening, and that you haven't left the coffee pot sitting on the stove or left anything else that could be damaged in travel. Then lock the door.

This truck and trailer rig uses a fifth wheel hitch like those used by big tractor-trailer trucks. The fifth wheel is mounted on the truck bed directly above the rear axle.

You should have a separate check list if you are a trailer owner for making sure you have done everything necessary in preparing your hitch, trailer and tow car for travel. Your RV dealer will explain this process to you when you pick up your new trailer. You might consider taking along a portable tape recorder when you take delivery of your trailer to record the helpful hints and instructions your dealer gives you. Some manufacturers today are producing just such tapes. You just drop it into your tape deck and listen as you travel or when you encounter trouble.

Mark down your trailer dimensions on a card and paste it onto the dash. It may be that government regulations will require manufacturers to display this information soon. In any case have it handy. It is particularly important to know the height of your vehicle when you are suddenly confronted with a low bridge, railroad underpass, or covered bridge.

Measure the RV width too, including the mirrors. Out in the Black Hills of South Dakota there is a roadway tunnel you can get through only if you remove your mirrors. Those who have paid no attention to width with mirrors on have had their mirrors taken off slick as a whistle, and then they had to buy new ones.

Good driving vision is vitally important so keep that windshield fluid bottle under the hood of your tow car or camper filled. Otherwise, you may encounter a summer storm, have to pass several semi-trailer trucks on the Interstate, and their wheels will throw up a barrage of dirty water that will cover your windshield and practically obliterate the view. This is when you'll be glad if you can just press a button and have a clean windshield again.

Those owning a pickup camper should always tighten the turnbuckles that help hold the camper to the truck bed, not only in the morning but each time you stop for gas. For a really comfortable ride in a pickup camper, you need stabilizers installed from camper to cab up front. But be sure you install them well down on the side of the cab cowl and use a reinforcing plate so the metal doesn't fatigue and the stabilizer rip out.

Before you take your first trip in your new rig, you should practice parking, backing, and becoming familiar with how it handles some place where there is no danger of hitting anything. An empty shopping center lot where there are parking spaces marked off on the pavement provide an excellent practice area.

When you do take to the highways, the divided Interstates allow you to move along with the traffic without having to pass until you get the feel of driving your trailer. Just remember, it is as easy to drive as your passenger car, but it won't stop on a dime, due to its sheer bulk, nor will it accelerate from zero to sixty miles an hour just by tromping down on the accelerator.

A neophyte house trailer owner is going to swear there isn't enough room on the road to accommodate his rig. Check that convex mirror and you'll see you have room to spare. The best method for keeping a trailer centered in the road is to pretend your foot on the throttle is right in the grease line you see on all highways. Your main difficulty, until you get the hang of it, will be to keep close enough to the white center line so you don't drop a wheel off the road.

Believe it or not, it doesn't take too many miles before you totally forget about the size of a motor home. You soon learn to swing wide at the corners, too, so you don't run the rear duals over the curb and throw all the dishes out of the cupboard. As soon as all this becomes second nature and you learn to drive more slowly whenever there are strong winds or adverse weather conditions, you'll have it made.

On steep downhill grades always downshift and let the engine compression act as

▲ *This house trailer is attached to the station wagon with a conventional trailer hitch.*

a brake rather than ride your automotive brakes. If you pick up more momentum than is safe, then apply the brakes a bit to slow you down again. Otherwise, riding the brake will cause you to experience brake fade. If you do, you'll never have to be told to downshift again. A run-away camping rig is a hair-raising experience. Slow down as soon as possible, get off the road and give the brakes a chance to cool then proceed at a slow pace for awhile.

In going up hills where you lose speed, again downshift so that you don't lug the motor and cause it to overheat. The high rpms sound dreadfully loud when you downshift and you may think you are doing more harm to the motor than good, but exactly the opposite is true.

Everyone should carry wheel chocks and remember to use them if you pull off the road to park temporarily. (Also use them in camp.)

Just a few more tips. When towing a compact car behind a camper you can't see it because it is narrower than your RV. Tie a handkerchief on the radio aerial and it will flutter out far enough that you can tell if the car is still attached.

Last, but still very important, never back up a trailer without first going to the rear of your rig to check for obstacles. Either do that, or have someone stand outside and guide you back. Take it easy when entering or leaving a gas station or shopping center with a steep driveway too. If you don't you will undoubtedly wind up with a crunched exhaust pipe.

See also: BOATING; CAMPERS; MOBILE HOMES; SAFETY, BOAT; TRAILERS, BOAT.

Buying a Trailer for Your Boat

The size and weight of your boat and the speeds you plan to tow it are the determining factors in your choice of a boat trailer. In general, don't skimp or you may pay more in the long run

IT IS ALWAYS SAD to see a boat trailer broken down on the highway. Someone's outdoor weekend shot, tow charges and repair bills mounting, sometimes people in danger. Not all of these broken hearted rigs are cheap, off-beat junkers that should never have been allowed on the highway in the first place. Some of them bear the names of our finest trailer makers. Has the trailer industry suddenly gone to pot? Hardly. There is more to this trailer business than meets the eye.

In recent years the boat trailer marketplace has been almost completely dominated by price. The bulk of the buyers want a long enough trailer with sufficient rated capacity, but from then on, price is supreme. On the surface, this seems sensible, until you understand capacity, as it applies to highway rolling stock. The physical forces and strains of various operating speeds are not understood by most trailer boatmen. It is one thing to have capacity for speeds around 45-50 miles an hour, quite another to have capacity for 65-70 mph freeway traffic.

Higher speeds make tire size and type critical to safe operation. Trailer tires are identified by a number system. A 4.80/4.00-8, for example means a tire with a cross section of 4.80 on a wide rim, 4.00 on a standard rim, with a wheel diameter of 8

trailers, fifth wheel: see campers
trailer shower: see shower

inches. This 4.80/4.00-8 in 4-ply construction has a rated capacity of 600 pounds, at 65 lbs. inflation. A pair of these will handle up to 1200 lbs. of boat, motor, accessories and trailer. But note the catch. This rating is for speeds of 50 mph or less. Now, if your car has 8.00-14 tires, and your trailer 4.80/4.00-8, the trailer wheels are going to turn a lot faster than the car's. A short track-man has to pick 'em up and lay 'em down more rapidly than his long legged competitor. It may surprise you to find how much faster the peripheral speed of the little trailer tire is, when compared with the ones on the car. See the accompanying chart for some equivalents.

Car tires are designed and built for sustained high-speed driving. Just how high depends a lot on the line rating. Your tire dealer can tell you at what speeds the manufacturer "red lines" the various grades. The 100 line (equal to original equipment), or better, are recommended for today's throughway speeds.

When you look at the figures, it is easy to see why some people get by swimmingly with small sizes, and why some have grief. When the little tire is spinning someplace between 90 and 130 mph, it generates heat in tires, wheel bearing and the spindles which support the wheels. When you consider the lack of maintenance most trailer bearings receive, plus the problems of dunking white hot bearings in ice cold lakes, it is little wonder that some trailers fail, even those with top-flight names.

So, the first thing to look for in any boat trailer is its tires. If your plans are for short hops at speeds around 50, get the needed capacity and length, then go in confidence. If you plan even one long trip at high speeds, get the larger sizes—or those rated for speeds above 50 mph. Experienced trailerists prefer car size wheels and tires.

Why doesn't everybody use 13-15 inch car wheels on boat trailers? The answer is money. Identical trailers, one equipped with 5.30/4.50-12 running gear and the other with 6.00x13 (American compact size) will show a difference of around $75. Even if your sailing dinghy only weighs 350 pounds and you plan to barrel down the highway, you need tires with high-speed capacity. Midgets, which will more than carry the load up to 50 mph, may well be churning around the equivalent of 100 mph at 70 mile freeway speeds. If you want to go above 50, get trailer tires designed for the swift.

All major trailer makers design frames, springs, axles, and hitches to safely handle the capacity they advertise. In the case of two trailers for a 16 footer ranging from $200 to over $500 there were many differences. The low price job was much lighter all around. The frame was ample, but not much more. The bigger job had a heavy steel frame which would withstand a lot of abuse on dirt roads and primitive launching spots. The axle on the cheaper job was light and narrow. The boat was loaded above the fenders, with a relatively narrow stance, making it less stable on rough roads. Its height made the launching and recovery harder. The expensive model had a wide, drop center axle. and the boat fit low between the 15-inch wheels, with more stability as well as an easier launch and retrieve. With a sturdy tilt, good winch, generous keel and positioning rollers, the better trailer is a dream around the ramp.

Another fringe was the minimum maintenance. With dunking unnecessary, you pack the bearings only three times a year. So, think it through before you buy a trailer on price alone. If your situation is an easy, slow-speed one, save your money with a reliable lightweight of one of the top brands. But if you are going to roll, even with a light boat, don't be penny wise and pound foolish. Get tires and wheels that can endure high-speed. If you do decide on car wheels, most manufacturers will duplicate these on your car for very little extra. Then

Your boat trailer must bear not only the weight of your boat, but ot the motor, gear, equipment and supplies that go into it. Figure on a towing weight of one quarter to one third more than the advertised weight of the bare boat.

the one spare will do for all. Even though trailers do not wear out tires as fast as cars, you do need a spare, when you need one. As a matter of fact, you can take the new tires off your trailer and substitute the ½ worn ones from your car, thus cutting down the price differential a little.

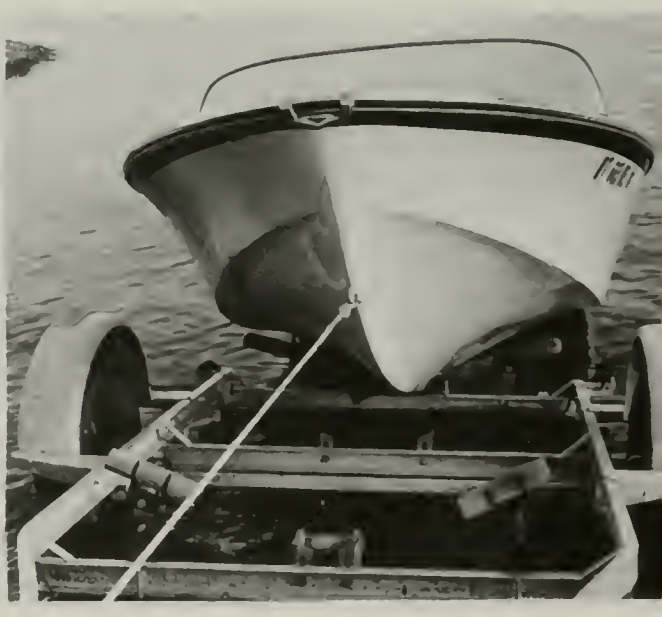
No matter which price trailer you choose, insist on class A lights, which include tail, stop and directionals. These are required by law, either those of the state, or those of common sense.

Basically, there are two popular hull support systems—rug covered wooden bolsters and rubber rollers. Many trailers provide rollers and bolsters together. Others go the roller route entirely. The solid bolster people point out that the pads give more support. The roller guys say that their system makes for much easier launch and load. No question about it so far. But the $64 question is, do you actually need the extra support of the bolsters? Some trailer experts say that bolsters may knock a boat's bottom out of shape. Others say you need them. Probably the best answer would come from the manufacturer of the boat you choose. He should know, if anyone will. One trailer maker fixes this with solid bolsters that may be lowered out of the way for easier on and off, which gives you a bit of both worlds. These extra dollars for a better trailer aren't wasted. But regardless of the roller-bolster argument, you need the best support you can get at the transom and under the keel. The transom is the strongest part of any of today's power boats. It has to be, to withstand the frisky horses attached to it, either outboard or stern drive. The transom should have full support, directly under the glass encased wood. This should come as close to fully supporting the transom board from keel to chine, as it is possible to get. The rollers or bolsters should be adjusted and matched to fit. Bridge the transom with all that weight on it and you will put an enormous strain on the vital section of your hull. Supports just forward of the transom, even a few inches, can give that planing bottom a hook that will throw performance to the winds. The rear section of any planing boat's bottom is key.

There is no question that solid bolsters make loading harder. Maybe that is why there are so many "dunking" trailer boatmen. Manufacturers climb walls when they

Properly positioned rollers can help guide the hull of your boat into a straight position to be hauled ashore. This is especially usaful on windy days.

Choose the correct winch as well as the correct trailer. This winch handle turns a small gear that turns the winch drum and offers a fairly high mechanical advantage for retrieving heavy boats.



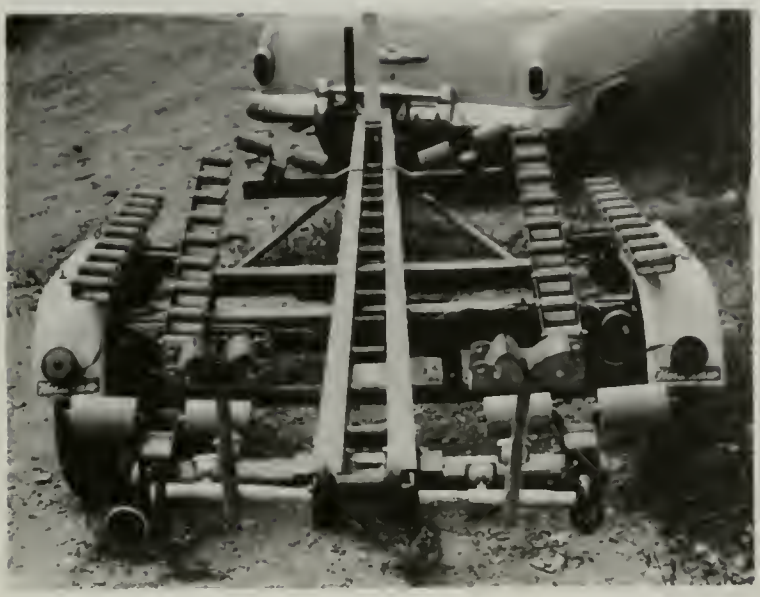
Matching the trailer to the hull makes it easier to haul the boat from the water without immersing the wheel bearings or lights of the trailer.

Mismatched stern chocks of this model are likely to damage the transom of the boat, once the weight of a motor, battery and gas tank is added. A long or bumpy trip could increase the risk of trouble.

Carpet covered butters of this light trailer could provide support for a small, light hull if the trips are short and the speeds are slow. Rollers would make launching and retrieval easier.

think of submersion. There is no reason why a properly engineered trailer must be immersed. With hot bearings (even big ones get warm under a long, fast drive) dunking creates a vacuum and sucks in water. Bearings rust, greases are diluted, and sometime later you may hear the trailer singing an unhappy tune. If the bearings seize, they can break the spindle and send the wheel and hub sailing off.

One important thing which every trailer needs is a set of swivel positioning rollers. When you start winching the boat up, these guide the keel into position. If you frequently load in windy spots, vertical rollers will be worth their weight in gold. For roller



Closely spaced rollers of this trailer make launching and retrieval as easy as possible and provide well distributed support. Individual contact points are not likely to dimple the hull.

Safety of your trailer depends on rugged, well designed fittings.

trailers and boats up to about 16 feet, the standard 3-1 winch is perfectly adequate. But if you want padded bolsters, go up to a 6-1 or a 6-1, 12-1 dual ratio winch. Geared down, these are a little slower, but a lot easier. For heavy boats, add the extra money for an electric winch, and you can still load with a dry axle. Dunking is a bad habit. Unless you have a keel sailboat or a monstrous inboard cruiser, rig and winch so that you load dry shod. It is better and safer for your trailer, better and safer for you.

What about brakes? Do you really need them? Well, like the insurance ads say, "if you ever need them, it's too late to buy them." Law-wise, Minnesota says brakes for any gross loads (trailer, boat, etc.) over 1,000 lbs. This covers the bulk of the outfits now on the road. Also 18 others say 1,500 lbs., while three say brakes if you can't stop in 40 feet from 20 mph. Remember that your car's braking efficiency decreases as it gets older. While brakes add considerably to trailer cost, they aren't such a big percentage of the total invested in car and boat, to say nothing of the value of the passengers. Electric brakes are fine, and a little less expensive. You have a rheostat controller at the steering wheel with the brakes actuated from the car battery. Surge hydraulics are completely self contained on the trailer. The hitch slides back as the car slows, operating a master cylinder to put a proportionate hydraulic pressure on the trailer shoes. The harder you hit the car

brakes, the more braking force you get on the trailer. Some tests indicate that with trailer brakes, the entire rig will stop as quickly as the car alone. It is no small safety factor, and probably won't cost you much over the long pull. Laws are getting tighter all the time and when you trade, the trailer with brakes will probably recover much, if not most of your original investment.

Shocks are available for some makes, and are a plus if you plan much travel in rougher areas. And for high-speed work, it's smart to have the trailer wheels balanced and leaded, the same as your car. No matter which price rig you select, get the proper capacity. Advertised boat weights tend toward the low side. As you own a boat, you add extra gear. Water weighs around 8 pounds per gallon, gas between 6 and 7. Batteries, 40 pounds, and you go on up from there.

▲ *Insist on a rugged nose cage to hold the bow. A strong one can prevent the boat from sliding forward during emergency stops.*

Before you leave the showroom, be sure you know about tire inflation. How much air does a 6.90/6.00-9 tire take? It depends, because there are 4, 6, 8, and 10 ply 6.90/6.00-9 shoes. These take 40, 60, 80, or 100 lbs. Find out what you have, and mark it on the fender. It takes guts to kneel there and pour 100 lbs. into one of those doughnuts, while the gas man screams, but forget it. The tire makers know more than he does.

Next time that knowledgeable salesman offers to throw in a set of wheels on an attractive package deal, lift the rug a trifle. You may like what you find, or you may discover that he is smarter about boats than he is about trailers.

Match your trailer to your boat as well as to your operating conditions and getting there will be routine. Your thrills and adventure will be on the water, as they should be, and not along the way.

See also: BOATING; SAFETY, BOAT; TRAILERING.

PERIPHERAL SPEED OF TRAILER TIRE

Trailer Tire Size	Percent Faster Trailer Tires Travel	Travel Equivalent for Trailer Tires and Car with 8.00-14 Tires Traveling at Speed of			
		50MPH	60MPH	70MPH	80MPH
4.80/4.00-8	68%	84.1	100.9	117.7	134.5
5.70/5.00-8	41.5%	70.8	84.9	99.1	113.3
6.90/6.00-9	29.97%	65.	78.	91.	104.
4.80/4.00-12	29.97%	65.	78.	91.	104.
5.30/4.50-12	23.60%	61.8	74.2	86.5	98.9
6.90/6.00-12	12 5%	56.3	67.5	78.8	90.

Maintaining Your Boat Trailer

Avoid annoying and possibly dangerous breakdowns by spending a few hours now and then to keep your boat trailer in good operating condition

THE FACT THAT THEY owe their boat trailers anything, let alone a couple of hours of maintenance, is a strange notion to some skippers. Trailers are such simple affairs, frame, wheels, winch, and rollers—what is there to service? The wheel bearings are the same as the car, and you only grease those every 15,000 or 20,000 miles. Most of us don't put that much distance on three boat trailers!

Fortunately there is a built-in safety factor in all but the cheapest trailers, so many people get by with gross neglect. But a day of reckoning could be lurking around the corner for those who are careless about their rolling stock. Trailer failures aren't common, but when tires peel tread, bearings seize, spindles break, wheels come flying off, you've got real grief. There are four ounces of prevention that are worth a ton of cure for boat trailers. Inspection-repair, tightening, lubricating, and finishing are keys to trailer maintenance.

Before you start your trailer work, gather the materials together:

A pressure oil can with 30 weight engine oil.

A couple of 2½-inch cotter pins.

One can of matching spray for minor touch-up; two cans if you want to refinish most of the trailer.

Scraps of synthetic fiber rug, if the bolsters are matted and shabby.

A can of solvent or de-gunk to clean the wheel bearings.

A can of tar remover to clean the frame.

A can of boat trailer, wheel bearing grease. It is important to get special grease. Small trailer wheels turn much faster than the car's, generating high heat which can cause some grease to melt, run, and fling off. Dunking also tends to make some lubricants emulsify and wash off. There are several products designed for this special

➤ *Squirt lubricating oil or, if necessary, penetrating oil into the lock latch. Salt water or road tar may be corroding or gumming it up. Also examine the safety chain for weak links, especially links that have been dragged on the pavement and abraded.*

➤ *Jack up each wheel and carefully remove the dust cap from the main wheel bearing.*

need. Don't use ordinary wheel bearing grease.

When "T" day comes, unlatch the tilt, and slide the boat off onto the lawn or onto a pad of old rugs and blankets in the driveway. With the boat off, you can quickly and easily run through the maintenance drill.

Inspection-repair. Like most fit-out work, this is a systematic search for problems before they become troublesome. With today's turnpike and freeway speeds, you just can't take chances. Go over the frame with a critical eye and a heavy hand. If any joints are questionable, have your welder run a bead on them. Get down and inspect the springs. Broken leaves are easy to miss and can let you down, if you fail to spot them. The coupler at the front is critical. Take it apart, clean and oil it. If anything is worn, get a repair kit from your trailer supply house and rebuild to new standards. Safety chains, too, need a close look. Sometimes they drag on the pavement, and one or two links may be ready to let go on the first strain. Make every roller turn. Squirt penetrating oil on the bearings of any that bind. Shabby rollers should be replaced. All major trailer manufacturers offer repair parts. Give your dealer the serial number and model when ordering parts.

➤ *With a clean surface ready to receive parts, remove the wheel and remove the outer bearing for careful inspection and cleaning.*

The winch line is important from a safety standpoint. If it is manila, it can rot. Replace it. Polyethylene, with its high strength and low stretch, is a favorite for winches, but even this is not forever. Look closely where it is spliced into the hook. Cut out short frayed sections, or replace the complete line. A winch line that parts under tension, can give you a fearful wallop.

Go over the light wiring from coupler to

➤ *Dunk the bearing races in solvent and roll them with your fingers. Inspect them for looseness or uneven rolling. If you have any doubts, replace them. When replacing wheel, be sure to grease bearings and spindle with a lubricent designed especially for boat trailers.*

taillight. Pull the clips that hold it to the frame and tape any worn insulation. The taillights are often in the water, which builds corrosion. Remove the bulbs and clean their base contacts as well as the pins in the sockets. Then hook up the car and make everything work. Tail, license, stop, and directional lights.

Tighten all bolts. There are a lot of bolted connections on most trailers. If you own or can borrow a set of sockets, this will go much easier. Put a wrench to every nut and bolt on the rig. Nuts tend to work loose under road vibration, so this is a good time to add lock washers, if the manufacturer missed some. Don't give up easily on frozen ones. Squirt penetrating oil on them, back off, and pull up snug. Unless you do this, you may pass an important bolt that is not tight, but is frozen with rust and dirt.

Do not tighten the bolsters and rollers while the boat is off the trailer. Instead, just make sure they aren't frozen, then tighten them after the boat is reloaded, adjusting all for good contact with the hull. Don't forget to tighten the winch to the mast, and the mast to the frame.

If your trailer has its own brakes, inspect the drum, brake shoes and hydraulic fittings while the wheel is removed.

While not a part of the trailer, the car hitch is an essential point to check. With the long overhang and soft springs of today's cars, they are often scraped in driveways. Sometimes you'll find hitch bolts sheared off on fit-out inspection. And someday one of the manufacturers of trailer balls is going to square off the base of the ball so it will take an end wrench. Until they do, you'll have to put a pipe wrench on the ball and an old fashioned monkey wrench on the nut and muscle her home. The lock washer is important here. If you ever hear a strange rattle on the road, check the ball for tightness. They seem to work loose with some frequency.

The running gear (axle, springs, fenders) are adjustable on most of the better rigs. It goes without saying that these should be snugged quite firmly.

Lubrication. Now you make like a grease monkey. That is one of the nice things about boat work. There are a great variety of different jobs to do. You've already serviced the coupler, but at the head end, put some of that wheel bearing grease on the winch gears, and oil the bearings. Next the tilt and tilt lock, followed by the bearings on all rollers. If there are pressure fittings on spring shackles and rollers, use a grease gun.

The wheel bearings are your trailer's vital organs. Like the coupler and hitch, they must be absolutely right. As mentioned earlier, use only special boat trailer wheel bearing grease. The procedure is simple. Jack or lift the trailer and block the wheels off the ground. Take care not to bend the dust cover when you remove it. If it is bent, replace it. Pull the cotter, discard it, unscrew the nut and give the wheel a short straight jerk toward you. Then push it back and remove the outer bearing. Now replace the washer and castellated nut on the axle, with the wheel still on the spindle. Pull the

Examine the tire treads carefully for excessive wear, removing any sharp stones or bits of metal or glass that are embedded in the tire. Rotate the tires, and don't forget to check the spare.

If rust is not removed, it will spread beneath the paint. Clean it away with a wire brush, by hand or by a brush mounted on an electric drill. Brush the surface down to the bare metal and touch-up the spot with spray paint.

wheel out until the inner bearing is against the washer and nut, and again give a short, straight jerk. This will usually dislodge the inner bearing and grease retainer, leaving them on the spindle unharmed. Some say that you should never re-use a grease retainer, but if there is no evidence of grease leakage, you may have good luck using them again. Take no chances, however. Replace if suspicious. Look at the inner and outer bearings closely.

If the bearings and grease are black, with a strong acrid odor, they've been running hot. Have an expert check the bearings, or replace them for safety. If they look all right, dunk them in the can of solvent and clean with a brush. Let them soak while you use solvent and a rag to clean off the spindles and the inside of the hub. Look and feel for rough spots on the bearing races which are press fitted inside the hub. Any irregularities demand new races and bearings. These mate up with each other, so if one is replaced, the other should be new also. Handle the bearings by their edges and check carefully for rust, corrosion or pitting. Replace if you find anything the least bit unusual. When they are clean, squirt some of that 30 oil on them and give them a spin. Loose bearings will sound and feel sloppy. Your fingers can detect the vibration.

Pack the bearings with as much of that special grease as you can shove into the edges and around the outside of the rollers. Place the inner bearing in its race, line up the grease retainer, put a wide piece of wood on the retainer, then tap it home. This puts even pressure on all sides of the retainer. If your trailer has brakes, clean

them up, making sure no grease fell onto the lining or drum during your wheel packing. Give the spindle a coat of grease, mount the wheel, put the outer bearing in place and tighten the adjustment nut until the wheel just binds. Then back off one or two castellations until the wheel spins freely. Put a new cotter in, cut one leg off flush, and bend the other around the nut. With the dust cap carefully tapped back, and the wheel lugs cinched up, you are set for a while.

Check the tires while you are here. Pick gravel, glass, and other miscellany and sundry out of the tread. Look closely at the point where the tire bead meets the rim. If you see sand, better demount the tire and clean the junk out. Abrasives here can cause a tire to fail. Then inflate to recommended pressure. You probably know what this is, but are you sure? Trailer tires range all the way from 30 lbs. to 100lbs., depending on size, load, and ply rating. Some sizes have as many as three or four maximum pressure recommendations, depending on the plies. Get a chart, check, then mark the pressure on the fender. The right-hand tire takes the beating. Rotate them so that you have your best to starboard, your worst as a spare on the rack. If there is evidence of uneven tread wear, you may need to have the tires and wheels balanced or the axle aligned again.

Appearance. A bucket of warm water, stiff brush, detergent, household abrasive, and a hose will improve appearance considerably. Use the tar removing compound to get the road muck off. Hit the rust spots with a wire brush until you are down to clean metal. If there is extensive rust, a wire brush in your ¼-inch drill will speed the job. But be sure you wear goggles for this. Paint and rust specs are miserable in the eye. Mask any chrome, step plates, decals or two-tone fenders, and fog away with your aerosol can. Don't try to blow it on with one thick coat, or you'll get a lot of runs and lace curtains. Easy does it; then come back and hit her again when the first coat is dry. Wonderful what a little elbow grease, a little wheel bearing grease, and a little paint can do for a trailer. Replace the carpeted bolsters, if the padding is shot.

If you are one of those boatmen who always submerge to launch and load, you should re-examine your thinking on this. Dunking is mighty tough on bearings, and wet loading is actually much harder than loading dry. Check with your dealer and see if it isn't possible to update your "submarine special" with the latest rollers, and perhaps a new winch. With positioning rollers, guiding the bow and keel right into place, side guides, and some of the other attachments, you may be able to come ashore as easily as the best of them. If your old winch is getting tired, consider one of the new lower geared jobs, or even a two-speed affair. The few dollars this costs can make loading a joy, instead of a chore. And how about some of those other handy extras, such as a jack or nose wheel for the tongue, new quick release tie downs, a dolly cart, or lifting handle. Your operating situation will determine the need, of course, but if you can use any of today's trailer accessories, you'll wonder how you ever got by without them. Trailers are simple, but the mass and weight can sometimes make them hard. Mechanical assistance for the tough jobs will be welcome relief, and may mean you can launch singlehanded.

You can hook up with satisfaction and assurance, once you have given your trailer its due. If you must dunk, have a heart, let the bearings cool, then repack often. If you can roll off and on dry, you can put off the bearing job for a thousand miles. And do watch your speed. When the average car is doing 70 on the turnpike, midget trailer wheels are spinning as high as 127 mph. Travel at reasonable speeds! F.C.C., JR.

See also: BOATING; CAMPING EQUIPMENT; MAINTENANCE, BOAT; SAFETY, BOAT; TRAILERING.

Lights for Your Boat Trailer

If you are out after dark without proper, reliable lights on your trailer, you are a menace to yourself and to other travelers

Typical taillight assemblies. Unit above has bracket for license plate and clear lens at bottom to illuminate the plate. It mounts on left rear of trailer. The unit at right is for right rear.

Clearance lights with red or amber lenses can be mounted to identify the size of your trailer. Make sure bulbs are easy to change and that you carry spares of each type you use.

When it comes to trailer lights, the safety slogan "The life you save may be your own," sums up in a nutshell the importance of a dependable lighting system. Every time the trailer boatman pulls away from a driveway or a launching ramp, day or night, it should be known from a personal inspection that all lights—tail, stop, turn, and clearance—are in perfect working order.

You've all probably had the experience, as you're driving at top highway speed at night, of suddenly discovering a fast-closing gap between yourself and a trailer boat being towed at what seems a snail's pace; the taillights are dull, or blink off and on intermittently, or only one is lit, and to top it off they're so low to the ground that they're even harder to see. The outboard motor or outdrive unit is projected rearward with nary a light, reflector, or red flag. As you pass, it's noticeable that the clearance lights (required in your state) also are afflicted with similar maladies.

Zooming past, you glance in your rearview mirror and observe that the trailerer has dutifully signaled a change of lane to pull around an even slower moving tractor-trailer truck which is lit up like a Christmas tree and looks like a miniature 4th of July celebration each time it flashes an intended lane change or turn. Unbeknown to the hapless driver, the turn lights on his trailer are not working and a driver coming up fast in the next lane is forced to make several quick decisions to avoid disaster.

Take a lesson from the truck drivers who make their livings on the highways; light yourself up so everyone around you knows where you are and what you're going to do. When you're cruising down the highway at 50 miles an hour you may think you're really flying, especially with a 3,000 lb. load behind, but to the fast cat in his new 385 hp super-charged Leopard you're standing still.

The cost of a good lighting system is a lot cheaper than endangering your life and property or paying a traffic fine.

It's been observed that many trailer

manufacturers, in order to keep their prices as low as possible (by public demand), install an inexpensive, minimal lighting system that will not stand up to the normal rigors encountered by boat trailers. Often when the trailer buyer selects his own lighting system as an optional item, he too wants to economize and unfortunately ends up spending more in the long run.

Many boatmen do not consider themselves electricians or mechanics and would rather concentrate on fishing. But it behooves every trailer boatman to know exactly how his lighting system works so he is prepared to make minor emergency repairs.

One method is to rewire your trailer yourself, getting advice where necessary to clear up the mysteries of how the lights work. Trailer lights function off the vehicle lighting system and require three wires: one for the tail and clearance lights, one for the right turn and right stop light, one for the left turn and left stop. On most trailers the lights ground to the trailer, which in turn is grounded to the car through the hitch connection or safety chain. This requires a three-way plug. However, a better practice is to have a positive ground, utilizing a four-way plug, which runs from the trailer to the towing vehicle.

Major reasons for lighting failure include wires dragging on the ground, which wears off the insulation and allows a short to occur, and corrosion in bulb sockets caused by water entering from submersion, rain or condensation. Two frequent causes of failure, often overlooked because of their simplicity, are a faulty ground and broken lightbulb filaments. The faulty ground can be cured with the installation of a positive ground system or by removing all the rust from the ball hitch and connecting surface areas on the trailer tongue. On vehicles, light failure is almost never the result of broken filaments because of the suspension systems used. But a boat trailer, with stiffer suspension, is subjected to a multitude of jarring shakes which cause filaments to snap often. This is particularly true when traveling over gravel or other rough-surface roads.

So for maximum protection, install a positive ground, check to see that the wiring is securely attached to the trailer frame, and make it easy to change bulbs. Some lights have a snap-out ring, some a face that screws off, and others a clamp requiring a screwdriver. Whatever your equipment may be, be sure it is convenient for you to manage. Be prepared to replace a defective bulb wherever you are by carrying an ample supply of spares. And don't forget to have spare fuses and know where the fuse box is located in the vehicle.

Never submerge your taillights. This can be avoided by using detachable taillights or a portable lighting system which is removed from the boat before launching. There are numerous varieties of bolt-on and clamp-on lighting systems available.

Reflector tape can be used to good advantage on a trailer. At the very least, put a reflector on your motor or drive unit, and for maximum protection install a removable red light.

Taillights installed at the top of side guide brackets will solve most launching submersion problems and also keep the taillights high for maximum visibility to oncoming traffic and when signaling lane changes.

Remember, you need a heavy-duty flasher unit for proper turn signal operation. Otherwise, the lights will blink on and off so fast that no one will ever know your intentions.

Above all, remember that the best defense to trailer lighting problems is a good offense. So when you buy your trailer, or if there's a boat trailer in your yard now, be sure you've taken every precaution to let the other guy know when you're coming and where you're planning to go. P.P.

See also: ELECTRICAL, AUTO; ELECTRONICS.

Ready to roam—and pity the landlocked camper! Note sleeper-box behind pickup's cab.

Bring along Your Boat and Your Trailer

Build a rig to piggy-back your boat and its trailer on a pickup truck and tow your own trailer behind

IF YOU OWN A BOAT, boat trailer, and travel trailer, you may have wished you could take them all on a trip with one towing vehicle.

The way to solve the problem is to equip a pickup truck for hauling the boat and boat trailer, thus freeing the hitch for towing the travel trailer. Upon arrival at a waterfront campsite, the travel trailer is parked, the boat and boat trailer unloaded, and the motor mounted. The boat and boat trailer are then ready to use in the conventional way.

The box or sleeper rig is of riveted construction, heavy aluminum angle covered with thin aluminum sheet and lined with half-inch-thick foam rubber for sound suppression and insulation. It supports the boat trailer tongue and is a compartment for a fourth person while traveling. It is accessible from the pickup cab through the cab's rear window opening. A boat attached between the sleeper and the cab seals out dust and moisture.

Pieces of one inch lumber lie loosely in the lower angles to form the floor. The floor cushion is of three-inch thick foam rubber. The outside dimensions of the sleeper are: length—75 inches; width—30 inches; front height—22 inches; and rear height—18 inches.

Aluminum channels serve as guides and tie-down points for the trailer tongue and wheels. The loading ramps are 8-foot long channels made from 2x4 and 2x10-inch #2 grade pine lumber. The 2x4's are bolted to the 2x10's at the ends and nailed in between.

▲ *Aluminum channel guides for boat trailer's wheels are seen in view at left. Machine bolts attach them to pickup's bed. Trailer's axle chains securely to them, as at right.*

➤ *Loading from terrain rise limits strain on winch cable. Ramps pin to channels.*

During loading and unloading the upper ends of the ramps are pinned to the rear ends of the wheel channels to hold them in place. The boat motor, ramps and other gear are carried in the pickup bed while traveling. The sleeper and wheel channels are bolted to the pickup bed with $\frac{5}{16}$-inch, NF thread machine bolts. There are eleven mounting bolts in the sleeper and five in each of the wheel channels. All of the mounting bolts to the pickup bed use large area ⅛-inch aluminum plate washers on the bottoms to distribute the bolt load over large areas.

Two persons load the boat and trailer in about 40 minutes with a ¾-ton cable hoist

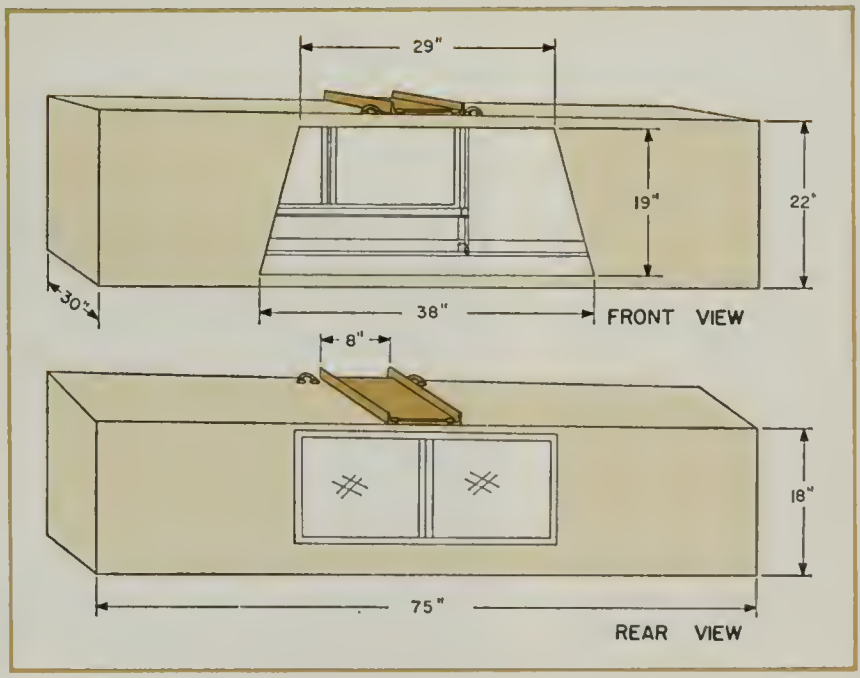
which has a 12-foot-long $^{3}/_{16}$-inch-diameter aircraft cable. The body of the hoist is hooked to a ¼-inch steel cable loop attached to the forward end of the pickup bed by a ½-inch U-bolt. The hoist cable is hooked around the trailer axle. The boat and trailer can be loaded from level ground, but higher elevation behind the pickup is preferred because of uncertainty as to the strength of the cable. In the vicinity of most campgrounds one should easily find suitable sites for loading and unloading.

The boat is a fiberglass 14-footer. The combined weight of the boat, 40-hp motor and trailer is 1100 pounds. The empty weight of the half-ton pickup truck is approximately 4000 pounds. The travel trailer is 15 feet long and weighs about 2000 pounds when loaded. Coil springs were installed on the rear shocks of the pickup to support the additional load.

While this rig was built for a 1964 Jeep half-ton pickup with a wide, 8-foot-long box, and a boat trailer with 62 inches between the centers of the tires, it should prove easily adaptable to pickups and boat trailers with different dimensions. The critical dimensions of both the pickup truck and the boat trailer should be carefully measured before materials are purchased. Many popular wide box pickups, for example, would require a floor support for the wheel channels as the tops of their boxes are wider apart than those of the Jeep. On the other hand, if the pickup has a narrow box, outside supports for the channels might be necessary.

An important thing to consider is weight distribution. The center of gravity of the load on the pickup should be well forward of the pickup's rear wheels, including the hitch weight of the travel trailer. Vertical center of gravity is kept low by storing as much gear as possible in the pickup box, rather than in the boat. The overall height should not be a problem. For the configuration shown, road height to the top of the boat windshield is under 10 feet. H.R.G.

See also: BOATING; CAMPERS; CANOE; CAR TOP; SAFETY, BOAT; TRAILERING; TRAILER, TENT.



Entry to sleeper is from cab. Aluminum channel atop it is for trailer's tongue.

Equip Your Tent Trailer with a Trunk

Use this easy-to-build compartment to carry your spare tires, tools and butane tank where you can get at them easily

A PLYWOOD TRAILER TRUNK stores and protects spare tires (they can be removed in seconds), shields the propane tank from rust-promoting rains, and also provides ample storage space for jacks, tool kits, a gasoline can, flashlights and other emergency gear. And you don't have to worry about losing a key or forgetting a padlock combination; though the front cover can be unlocked with a twist of the wrist, the lock system is so unobtrusive that only the nerviest sneak thief would risk searching for a way to open the trunk.

The construction materials consist of one 4x8-foot sheet of ½-inch thick plywood, a short length of ¾ x 12-inch shelving pine, six carriage bolts with nuts and washers, a short length of threaded rod, paint, and some scrap wood and metal. No dimensions are given because trailers have tongues of different sizes and shapes; also, each trunk should be tailored to accommodate the particular tires and gas tank to be stored in it. Just proceed according to the steps outlined, and you should experience no difficulty. One word of warning: watch those beveled edges and allow enough material for them by rough-cutting a little over-size, then working the pieces down to the proper sizes and shapes.

Step 1. Lay a piece of twelve-inch shelf pine across the rear part of the trailer tongue and place the gas tank and tire on the board in order to determine the height of the backboard. It need be no more than an inch higher than the largest stored item, but it should extend downward to a half-inch below the underside of the channel iron of the trailer tongue. Cut out the backboard, notch to fit the channel iron, and screw or nail to the rear of the tank shelf which as been cut at a diagonal on both ends.

Now cut a plywood floor to extend from the front of the tongue to the backboard. (This is easier if you first make a pattern using a large sheet of corrugated cardboard.) Do not at any time fasten the floor to the backboard; it will be held in place with four bolts so that the trunk can be dismounted easily by simply removing these bolts. The two bolts passing through the tank shelf and the floor are placed close to (not through) the channel irons, as shown. Use large washers underneath the nuts.

Caution: There should be at least four inches of clearance between the top of the trunk and the extended trailer bed so that the gas valve can be operated by reaching through the hatch in the top of the trunk even when the trailer is open.

Step 2. The front end of the floor is secured with two more bolts passed through a top crosspiece and a filler block (made from a piece of two-by-four). The thin plywood crosspiece shown in the illustration was later replaced by a thicker crosspiece

made from two-by-four for the sake of more solid construction, and to raise the lower edge of the front door to a more convenient height for easier removal.

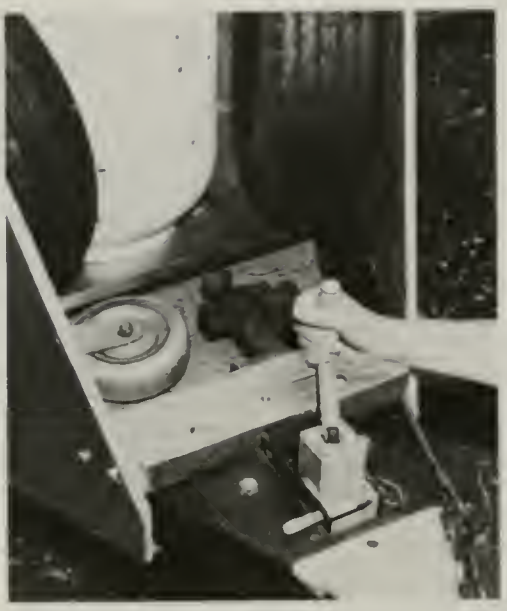
Step 3. Rough-cut the side panel a bit oversize and tack-nail into place. Lay a board across the top to determine the depth of the top panel, and to lay out the slope of the front panel. Check with a spare tire to make certain that it will fit. Cut the side panels, then screw and/or nail firmly to the backboard, to the ends of the tank shelf, and to the front crosspiece. Do not fasten the sides to the floor panel.

One reason for slanting the front of the trunk is to improve its appearance. The more important reason is to provide plenty of room for turning the trailer jack handle without skinning knuckles.

Step 4. Position the gas tank at the exact center of the shelf board and mount it firmly with two rigid metal strips that bolt to the shelf and hook into slots in the base of the tank. Cut a hole in the rear wall for the gas line, and another for the trailer signal light cable which can be run through the inside of the trunk.

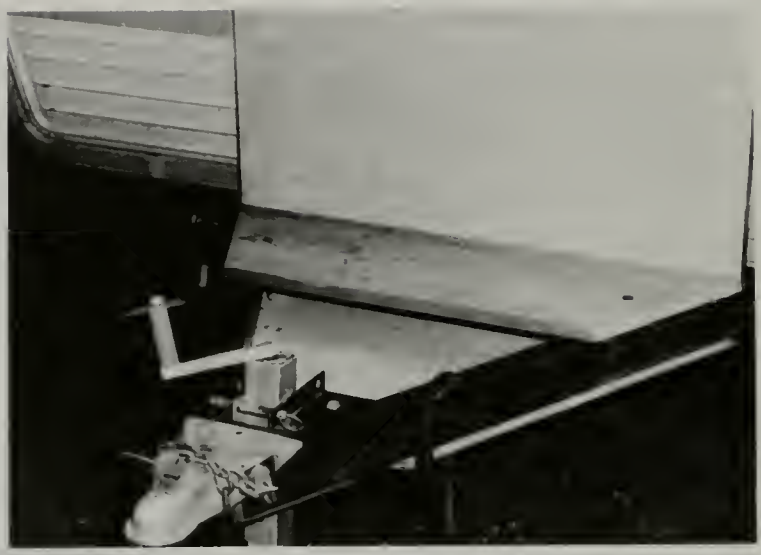
The photo also shows the door locking device. Wait until step 8 to locate and assemble this! It consists of a ⅜-inch threaded rod passing up through the floor, filler blocks and crosspiece. A square nut is embedded into the top side of the filler block and is held in place by the overlying crosspiece. The nut must not turn. The action will be smoother if the threaded rod passes through a snuggly fitting (but not binding) metal tube forced into the holes in the wood blocks. Find some sort of knob that can be firmly fastened to the lower end of the rod, and grind the other end into a rounded taper. The rod should be just long enough to project about half an inch out of the crosspiece when the knob is turned to its "closed" position.

Step 5. Before fastening the top panel in place, cut out the circular opening over the gas tank. This should be about 8 inches in diameter. A hinged lid is not feasible because the trailer bed may prevent it from opening fully.



▲ *Top lid provides easy access to gas valve. Slanted front provides hand room to operate jack. Tires bolt to walls. Jacks and tools store in roomy lower compartment.*

▼ *No visible hinges or locks, but box opens at twist of a hidden knob.*



Notched backboard fits between channel irons, butts floor panel's end.

Bolts through crosspiece and filler block secure floor panel's end. Thicker crosspiece may be better.

The plywood disc obtained when cutting the hole can be converted into a handy cover. Bevel the edge of the disc slightly so that it drops easily into the hole, then fasten it to a slightly larger square plywood panel. Cut ¾-inch slots into the edge of the hole as shown. The ends of a metal rod, firmly stapled to the underside of the lid, drop through these slots. A slight twist of the lid locks the lid in place.

Step 6. To prevent the lid from jiggling out of alignment when traveling, add a simple spring catch. Drill a large hole into one end of any available piece of spring metal and put a large round-headed bolt into the hole. Fasten with a nut and hammer it to rivet it into the bolt. The rounded end of the bolt engages a round hole cut into the edge of the circular part of the lid.

Note that a shaped block of wood is fastened to the rear wall of the trunk to act as a buffer for the top rim of the gas tank. A hook made from a heavy screw eye is positioned on the block so that a quarter turn will hook it onto the top edge of the gas tank.

Step 7. After shaping the front door panel (bevel all edges, including the bottom edge), add wood cleats near the inside (side) edges to prevent the door from sliding sideways. Bevel the outer sides of the cleats slightly to prevent binding.

To the underside of the trunk top add two rigid angle irons as shown. The projecting tab is about 1 x 2½-inch. These can be cut from lengths of 1-inch aluminum angle iron and spread slightly wider by squeezing in a heavy vise. From rigid metal, fashion two locking tabs that are screwed to the inside of the cover. These are placed so that they can be "hooked" behind the

Equip Your Tent Trailer with a Trunk

Tack rough-cut sidewalls in place to determine the depth of top panel and the degree of front slant.

Remove, reassemble. Note thicker crosspiece. Hole in back wall is for gas hose.

Lid is cut-out disc on plywood square with added locking bar. Finger points to secondary locking device.

Lid is secured by knob on metal engaging hole. Quarter turn locks hook on block onto gas tank rim.

angle irons. Properly adjusted, they hold the top edge of the door snugly in place.

Step 8. The locking device on the lower edge of the door is also made from 1-inch wide angle iron. This must be squeezed to less than the original 90-degree angle so that the projecting tab lies flush against the crosspiece on which the lower edge of the door rests. A hole drilled into the tab is slightly larger than the diameter of the threaded rod.

Put the door in place, and mark the position of the hole on the crosspiece. Drill the hole for the threaded rod and assemble the screw mechanism. When the hidden knob under the trunk floor is turned, the tip of the rod engages the hole in the angle iron to lock the lid firmly in place. The only visible part of the door locking system is the knob, and this can be seen only by lying flat on the ground and peering underneath the trailer tongue.

Gasketing material may be added between the door and the trunk edge to make the box more waterproof.

Tire mounting. Each spare tire is simply bolted to one wall of the trunk. Just mark the center positions and drill holes to take carriage bolts. Insert the bolts from the outside, and fasten the tires in place with the same sort of screw-on clamps used to hold spare tires in most cars. Thus mounted, the tires can be freed and rolled out in seconds. If only one spare is carried, the extra space can be used for other gear.

Finishing. The inside of the box can be painted or otherwise made water resistant. Finish the exterior to match the trailer. Be sure to use a sealer coating on the plywood before painting or it will be hard to hide the wood grain pattern.

To install the trunk on the trailer, position the floorless trunk on the trailer tongue. Fit the floor board in place and fasten with four carriage bolts. Finally, screw in the door locking rod. J.H.

See also: CAMPERS.

▲ *Top of removable front panel is held by metal tabs engaging angle irons near corners of top panel.*

➤ *Hole in angle iron at bottom of front panel engages threaded rod passing through front end assembly.*

Learn to Sail in a Pram

This sturdy, wide-beamed dinghy can be sailed, rowed, or propelled with a small outboard

THIS STRONG, BEAMY, eight-foot pram may be sailed either cat-rigged or sloop-rigged. The daggerboard may be adjusted forward to balance the helm when sailing with the addition of the jibsail. Oars or a small outboard motor may also be used to power this versatile craft. Before the construction begins, a few general procedures will apply: all screws will be flat head galvanized steel and will be slightly countersunk; when plywood is connected to hardwood, the screw will be slightly countersunk in the plywood, not the hardwood; all plywood will be exterior grade; all wood-to-wood attachments will be with screws and waterproof glue.

Construction begins with the full-size drawing of the outlines of the stem, mold #1, mold #2 and transom on ½-inch plywood. All curved lines are drawn by driving small brads at the ends and center of the curve, springing a thin batten along the brads and, using the batten as a guide, drawing the curves. Cut out these four panels noting that only mold #1 and #2, not the stem and transom, are notched for sheers, chines, keelson and stringers.

Bevel the stem and transom to the dimensions shown, using a plane or "Surform."

Next, cut the stringers to size; nail the 1 x 6 braces, 2 x 4 cross braces and ½-inch shelf brace to the stringers as shown. Erect the entire stringer assembly onto two sawhorses. Securely brace the sawhorses as required to prevent any shifting of the stringer assembly during construction. Notice that the top of the stringers are in the same plane as the bottom of the seats.

transformer, bell: see doorbell, chimes
transformer radios: see high fidelity systems
transistor radios: see high fidelity systems
translucent panels: see panels

This facilitates construction of the seats later on.

Now, attach mold #1 and #2 to their 1 x 6 braces with wood screws (no glue). Use shims, if needed, to align the molds properly.

Attach the stem and transom to their 1 x 6 braces with wood screws (no glue). Be careful to properly align the stem and transom with the stringers.

Cut out the framing for the stem and transom from ¾ x 1½-inch hardwood. Clamp this framing in place temporarily before beveling and notching it for sheers, chines and keelson. Spring a thin batten to simulate the action planking. This will provide a guide for the angle of bevel required and a guide for how much bevel is required on the inside faces of the notches. Notice that the part of the framing that supports the seat is beveled. Attach all the framing to the stem and transom with glue and 1-inch #8 screws on 3-inch centers.

Now attach the keelson, beveling the ends to fit snugly against the stem and transom, with glue and two 1¾-inch #8 screws at each end. If the keelson is difficult to bend into place, wrap it with rags and pour hot water onto the rags. Wood soaked in hot water like this will bend much more readily than dry wood. Note that the keelson is not attached to the two molds.

The sheers are fitted and attached in a similar manner: with glue and one 1¾-inch #8 screw at each end. Remember to spring the sheers into place together to prevent the boat from becoming lop-sided because of pressure from only one side.

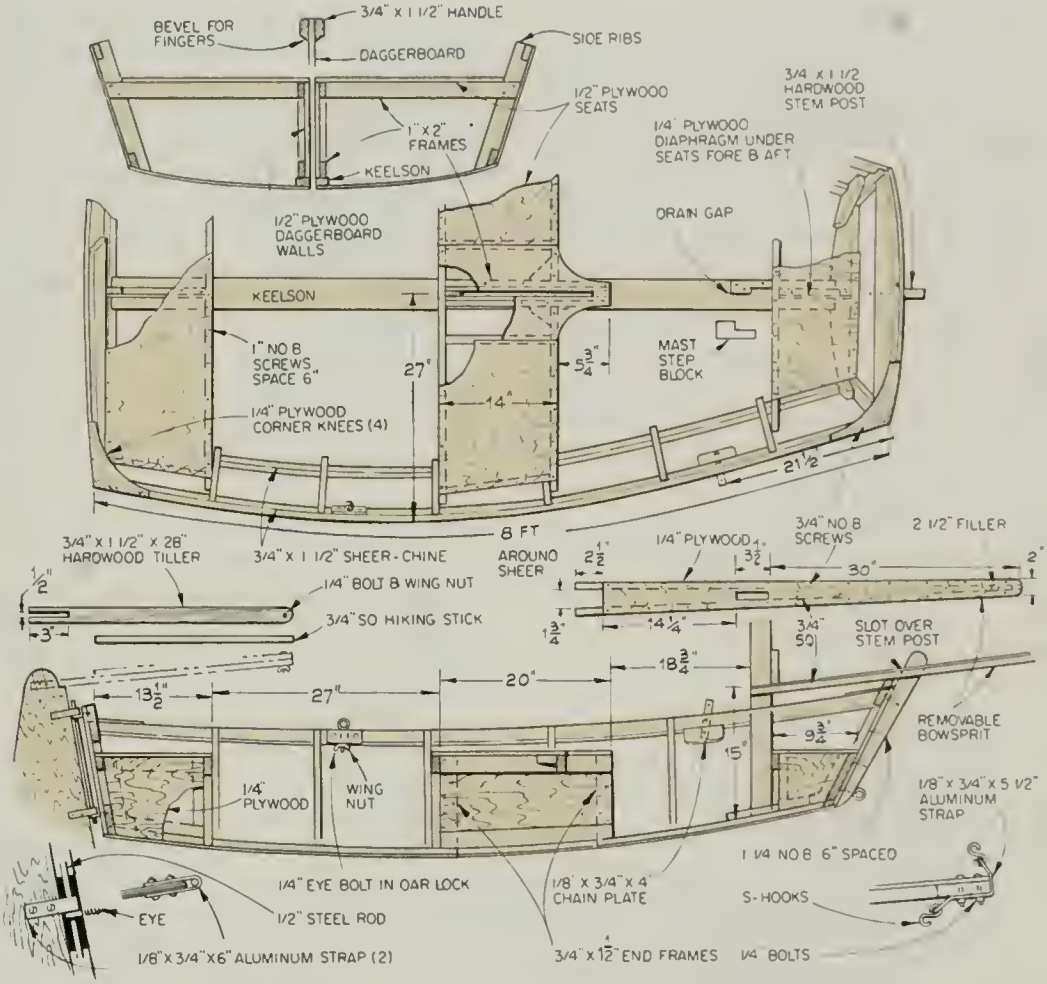
The chines are fitted, sprung into place and attached the same way as the sheers; however, since the chines are being bent in two directions, horizontally along the curve of the side planking and vertically along the curve of the bottom planking, they will have a tendency to twist. This can be overcome by clamping 1 x 4s at the chines mid- and quarter-points. These 1 x 4s can be used as levers to take the twist out of the chines and, after being loosely clamped to the sheers, will keep the chines from twisting.

The following is optional: chine blocks. Chine blocks make a stronger boat and, for the beginning boat builder, overcomes slight imperfections in the fitting of the chine ends. Chine blocks are simply ¾-inch hardwood pieces cut and beveled to fit around two sides of the chine. Attach the chine blocks to the stem and transom framing with glue and two 1½-inch #8 screws.

Cut the ribs from ¾ x 1½-inch hardwood. There are six ribs on each side of the boat, the ribs being located at the seventh points of the sheers. Each rib is notched at the sheer and chine and is located perpendicular to the sheer. Check the ribs on one side of the boat with the ribs on the other side for symmetry of location and length. Attach ribs with glue and one 1¼-inch #8 screw at both sheer and chine. Relocate the 1 x 4 levers as required while attaching the ribs; then, after all the ribs are installed, remove the 1 x 4 levers entirely.

Install the seat framing. The seat framing consists of six lengths of hardwood, two of which are already attached to the stem and transom. Of the remaining four lengths, one is attached later after the daggerboard case is installed and three are installed now, each length simply laying on the top of the stringers and extending across the entire width of the boat and slightly beyond the ribs. Bevel the ends of each length to fit snugly against the side of its rib. Attach the seat framing to the ribs with glue and 1¼-inch #8 screw at each end. Trim off the excess portion of the seat framing that extends beyond the ribs.

Then fit the fore and aft seat braces using ¾ x 1½-inch hardwood for the framing and ¼-inch plywood for the diaphragm. Attach the framing one piece at a time with



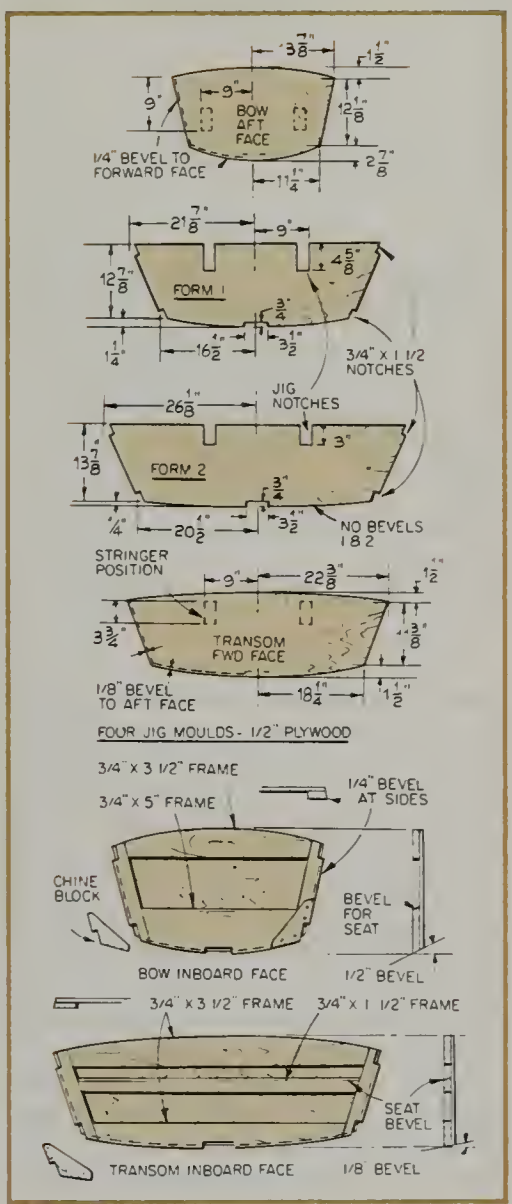
glue and two 1¼-inch #8 screws, then attach the diaphragm with ¾-inch #8 screws on 3-inch centers.

Assemble the daggerboard case of ¾ x 1½-inch hardwood and ½-inch plywood. Notice that one side of the daggerboard case is planed to fit snugly against the keelson and the other side of the daggerboard case lines up with the underside of the seats. Fasten the ½-inch plywood sides of the daggerboard case to the ¾ x 1½-inch pieces that abut the keelson and seat with glue and 1-inch #8 screws on 3-inch centers. Stagger the screws. Then attach the side assemblies just made to the ¾ x 1½-inch daggerboard case spacers similarly. Now, attach the entire daggerboard case to the keelson with glue and two rows of 1½-inch #8 screws on 3-inch centers. Attach the seat framing to the daggerboard case with glue and one 1½-inch #8 screw.

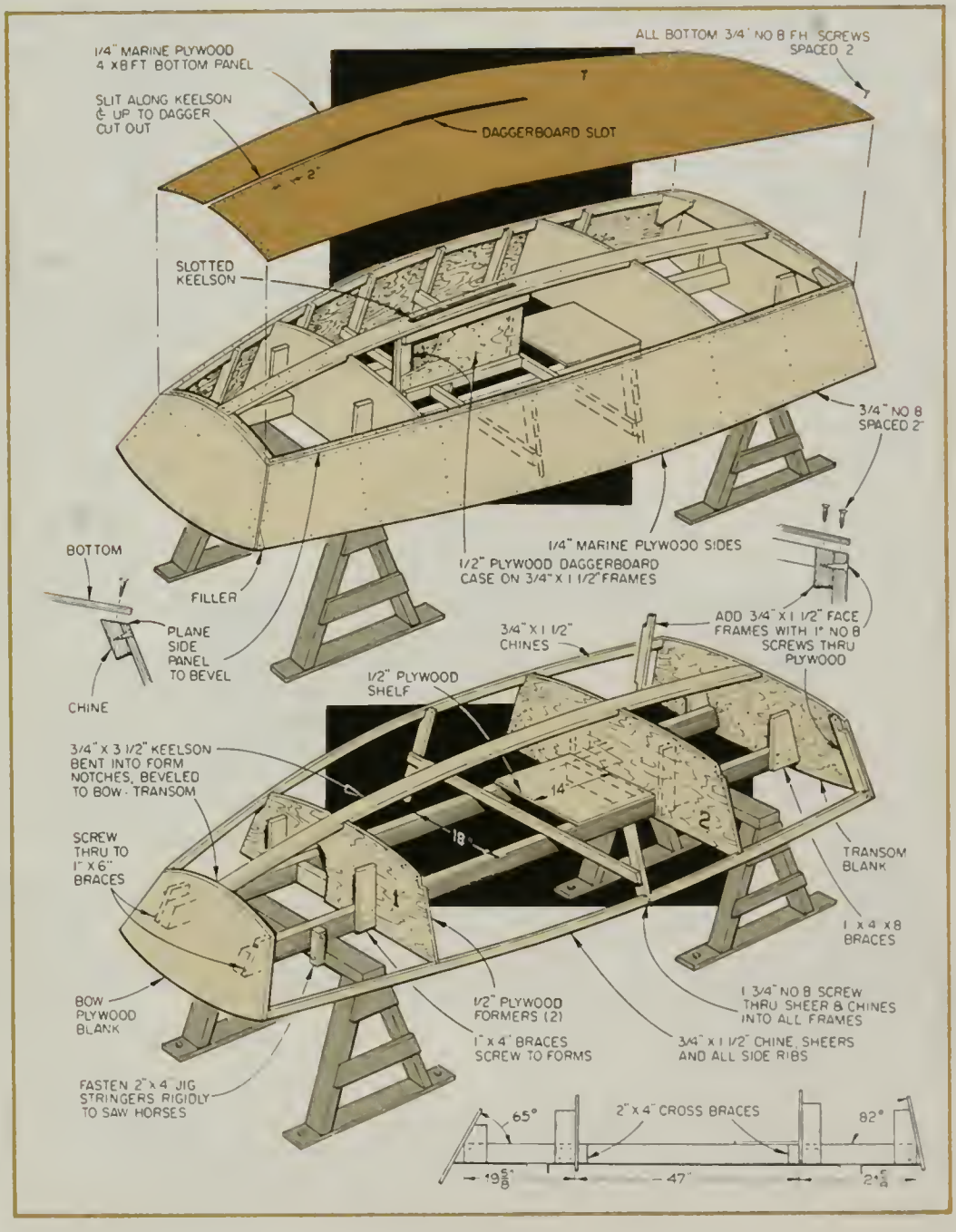
Now, the remaining length of seat framing is fitted, being cut into two pieces and attached to the ribs the same as the other seat framing. The ends of this seat that abut the daggerboard case are attached to triangular pieces of ¾-inch hardwood with glue and one 1¼-inch #8 screw. The triangular piece is attached to the daggerboard case with glue and one 1¼-inch #8 screw. A slot must be cut in the keelson

directly in line with the daggerboard case opening. Bore several holes in the keelson, then, with a keyhole saw, cut out the slot. Use a rasp to square off the slot with the daggerboard case opening.

In preparation to planking the boat, the framework must be faired. Fairing consists of careful work with a plane or "Surform" to smooth off all the side members: sheers, ribs, chines, stem and transom and their side framing to receive the side planking, and all the bottom members: chines, keelson, stem and transom and their bottom framing to receive the bottom planking. If chine blocks are used, they are faired, too. Proper fairing will allow the planking to lay flush against the framework at all points with no gaps or spaces. Spring a thin batten or length of ¼-inch plywood along the framework to simulate the planking. This will act as a guide in this precise work. After fairing, fit the ¼-inch plywood side planking by clamping the plywood to the sheers and marking the outline of the chine, stem and transom on the plywood. If the side planking is difficult to bend into place, spread a rag on it and pour hot water on the rag. Remove the plywood, cut out the side planks, oversizing them somewhat to allow for trimming, and spring both side planks into place together. The side planks are attached to the sheers, chines, ribs, stem framing and transom framing with glue and ¾-inch #8 screws on 2-inch centers, staggered slightly to prevent the side planking from splitting. Start attaching the side at the rear of the boat. Notice that the side planks will be about 1-inch short. Cut out a small triangle of excess ¼-inch plywood and fasten it with glue and one ¾-inch #8 screw.



Fair the side planking to make sure the bottom planking will lay flush at all points. After fairing, fit the ¼-inch plywood bottom planking by laying it in place on the bottom framework, lining up the edge of the bottom planking with the transom. Using a pencil taped to a stick, reach up inside the daggerboard case opening and draw the outline of the slot in the keelson on the bottom planking. Remove the bottom plank and saw cut it from the stem edge to the aft side of the slot outline. Replace the bottom planking on the framework and attach temporarily to the keelson with ¾-inch #8 screws on 12-inch centers (use no glue



on this temporary attachment) along both sides of the slot and from the slot to the transom. Push the bottom planking down onto the corners of the boat and mark the outline of the transom, side planking and stem on the plywood. Use rags and hot water if needed. Notice that when the bottom planking is pushed down onto the stem,

the saw-cut edges overlap. Mark a line along these edges that is coincident with the centerline of the keelson.

Remove the plywood, cut out the bottom planking, oversizing it somewhat to allow for trimming except at the saw cut edges which must match at the centerline of the keelson, forward of the slot. Cut these lines exact as they must butt against each other. The bottom planking is fastened to the keelson with glue and a double row of ¾-inch #8 screws on 2-inch centers and to the transom framing, chines and stem framing, with glue and a single row of ¾-inch #8 screws, slightly staggered. Fill the saw cut from the slot to the stem with a thick mixture of glue and fine sawdust. Use this same glue and fine sawdust mixture to cover all screw heads. Sand entire hull lightly until smooth and round off all edges of planking except at the sheer.

Remove hull from stringer assembly by detaching all 1 x 6 braces. Turn hull upright on floor and remove both molds.

Cut the three seats from ½-inch plywood and fasten to seat framing with glue and 1-inch #8 screws on 6-inch centers. Remember to slot the middle seat at the daggerboard case opening. The ends of the seats may follow the curve of the hull as shown or may be squared off at 90 degrees.

Cut out the mast step and the two chain plate blocks from ¾ x 3½-inch hardwood. Note that the mast step is in two pieces to allow draining. Fasten the mast step with glue and four 1¼-inch #8 screws and the chain blocks with glue and two ¾-inch #8 screws. Bevel the top of the stem and stem framing with a plane to blend with the sheers. Continue this bevel from the sheers towards the middle of the top of the stem where the bevel is parallel to the line of the bowsprit. Cut out the stempost from ¾ x 1½-inch hardwood and fasten with glue and 1¼-inch #8 screws on 6-inch centers.

Cut out the stem knees and the transom knees from ¼-inch plywood. Fasten each knee with glue and five ¾-inch #8 screws, warping the knee to fit the sheer and the stem or transom.

The daggerboard and rudder are cut out of ½-inch plywood. The daggerboard handle is made of two pieces of ¾ x 1½-inch hardwood, rounded at the edges with a finger grip cut into the lower side. Fasten the handle with glue and three 1¼-inch #8 screws, staggered. Round off the edges of that portion of the daggerboard that extends below the keelson and that portion of the rudder that is underwater to provide less resistance to the water. A length of ¾ x 1½-inch hardwood, slotted carefully at one end and reinforced with a ¼-inch bolt is the tiller while a length of ¾ x ¾-inch hardwood is the hiking stick. Join the tiller to the rudder and the hiking stick to the tiller with a ¼-inch bolt and wing nut.

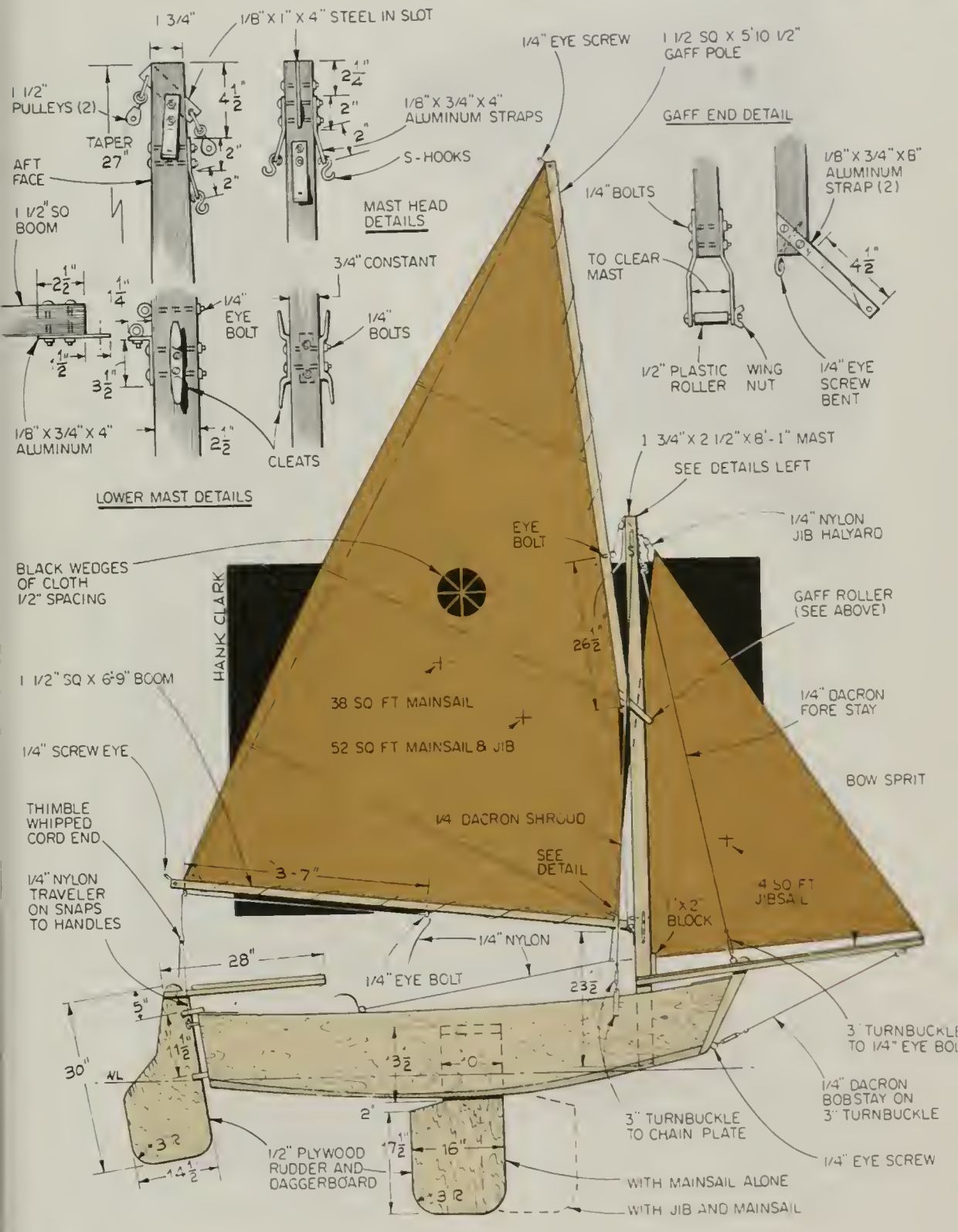
The mast is shaped from an 8-foot length of 1½ x 2½-inch spruce or fir. Bevel the bottom of the mast to fit the keelson curve and taper the top as shown. Round off all edges to about ¼-inch radius except at the bowsprit block, which is fastened to the front of the mast with glue and four 1¼-inch #8 screws.

The gaff is shaped from an 8-foot length of 1½ x 1½-inch spruce or fir. Taper the gaff from a square cross-section at the lifting ring location to a circular cross-section at the ends.

The boom is shaped from a 6¾-foot length of 1½ x 1½-inch spruce or fir. Taper the boom from a square cross-section at the end nearest the mast to a circular cross-section at the other end.

The bowsprit is ¼-inch plywood fastened to two ¾ x ¾-inch lengths of hardwood with glue and ¾-inch #8 screws on 6-inch centers. Slot the plywood to fit over the stempost and attach a ¾-inch hardwood filler with glue and two ¾-inch #8 screws.

Most of the boat's hardware is cut from


1 3/4"
1/8" X 1" X 4" STEEL IN SLOT
1 1/2" PULLEYS (2)
TAPER 27"
AFT FACE
1 1/2" SQ BOOM
1/8" X 3/4" X 4" ALUMINUM STRAPS
S-HOOKS
MAST HEAD DETAILS
3/4" CONSTANT
1/4" EYE BOLT
1/4" BOLTS
CLEATS
1/8" X 3/4" X 4" ALUMINUM
LOWER MAST DETAILS
1/4" EYE SCREW
1 1/2 SQ X 5'10 1/2" GAFF POLE
GAFF END DETAIL
1/4" BOLTS
TO CLEAR MAST
1/2" PLASTIC ROLLER
WING NUT
1/8" X 3/4" X 8" ALUMINUM STRAP (2)
1/4" EYE SCREW BENT
1 3/4" X 2 1/2" X 8'-1" MAST
SEE DETAILS LEFT
1/4" NYLON JIB HALYARD
EYE BOLT
BLACK WEDGES OF CLOTH 1/2" SPACING
HANK CLARK
GAFF ROLLER (SEE ABOVE)
1 1/2" SQ X 6'9" BOOM
38 SQ FT MAINSAIL
52 SQ FT MAINSAIL & JIB
1/4" DACRON FORE STAY
BOW SPRIT
1/4" SCREW EYE
1/4 DACRON SHROUD
THIMBLE WHIPPED CORD END
SEE DETAIL
4 SQ FT JIBSAIL
1/4" NYLON TRAVELER ON SNAPS TO HANDLES
1"x2" BLOCK
1/4" NYLON
1/4" EYE BOLT
3" TURNBUCKLE TO 1/4" EYE BOLT
1/4" DACRON BOBSTAY ON 3" TURNBUCKLE
3" TURNBUCKLE TO CHAIN PLATE
1/4" EYE SCREW
1/2" PLYWOOD RUDDER AND DAGGERBOARD
WITH MAINSAIL ALONE
WITH JIB AND MAINSAIL

4'-6"
9"
90°
1 3/4"
7
JIB SAIL
4 OZ. DACRON
LAYOUT
LINE
1/4"
6'-11"
6
6'-2"
STRAIT
10"
5
4
1" HEM
TYPICAL
2"
MID
POINT
11'-9"
3" MIDPOINT
3
7'-11"
LUFF
FIRST CUT
1"
FINAL CUT
LINE ALL
EDGES
1/2" SEAM
TYPICAL
2"
MAIN SAIL
4 OZ. DACRON
90°
2
4" X 8"
TACK
38"
STRAIT
1
LAYOUT LINE
90°
8 3/4"
6'-5"
1" AT 1/3 POINT
TACK

¾ x ⅛-inch aluminum bar, each piece being bent and drilled as required and all cut ends being filed smooth and the corners slightly rounded. Five pulleys, four lifting handles, two oarlocks, a 1 x 4 x ⅛-inch steel plate and four S-hooks complete the hardware.

After positioning the hardware and drilling the required bolt holes, the hull and spars are finished.

Waterproof all planking seams with 3-inch fiberglass tape and resin.

Finish hull inside and out with marine paint and finish all spars plus tiller and hiking stick and daggerboard handle with varnish. Apply both according to manufacturer's directions. Color and trim is according to the builder's taste.

All standing rigging is ¼-inch Dacron line: the two shrouds, forestay and bobstay. Each line has its ends eye-spliced around a steel thimble. A small plastic fid makes this easy work. The lower end of each line is attached to a turnbuckle and the upper end is attached to an S-hook.

All running rigging is ¼-inch nylon: the main halyard, jib halyard, main sheet, jib sheet and traveler. The cut ends may be whipped or scorched to prevent fraying.

The sails are made from, preferably, 4 oz. Dacron, although a lighter weight Dacron, nylon or cotton may be used. Don't use an old bedsheet or similar cheap cloth because the end result won't be worth the effort required. All stitching on the sails is zig-zag stitching using nylon thread for Dacron or nylon sails and strong mercerized cotton thread for cotton sails.

Lay out the sail patterns on a smooth wood or tile floor. Use marking tape to mark the sail outlines on the floor, using, for example, 1-inch long pieces of tape spaced about a foot apart. The four corners of the mainsail and the three corners of the jibsail are tape-marked first. The straight line connecting the corners may be temporarily tape-marked and the offsets measured and tape-marked. Then the curved edges of the sails are tape-marked. The sail cloth is then carefully laid out on the floor and taped down or held down with weights. Draw the outline of the finished sail on the sail cloth; draw the rough cut-line. The rough cut-line is where the sail cloth is actually cut out to allow for hems and trimming. The rough cut-line is 3-inches at all edges to be hemmed.

Draw and cut out pieces 1 and 2 (allowing 1-inch for the seam allowance) and sew together. Use straight pins to hold the seam allowance in place before sewing. To handle this large amount of sail cloth on a zig-zag sewing machine requires two people: one sewing and one controlling the feed of the cloth. Rolling the cloth into a long tight cylinder helps to feed through the sewing machine.

Lay the seamed pieces 1 and 2 on the floor and draw and cut out piece 3 and sew to piece 2. Continue one piece at a time until all seams are made.

Lay the rough cut sail on the pattern and draw and cut the final cut line at 2-inches beyond the outline of the finished sail. Then sew the hem edge after first pinning the hem in position. Care must be taken to smooth out any wrinkles in this hem. Cham-

fer all the pointed corners ½-inch. Cut out the tacks, one for each corner for reinforcement. Fold the edges of the tacks over ½-inch and sew to the sail. Install ¼-inch brass grommets. A simple grommet installation kit is easily available to assist in this. Cut out the batten pockets; fold the edges and sew to the sail similar to the tacks, leaving the outer end open for the insertion of the battens. Sew battens at the third points of the leech. The battens are ¼ x 1½-inch plywood strips 12 inches long with smoothed edges and a hole drilled in one end. This allows the batten to be tied to the grommet to keep the batten in its pocket.

See also: BOAT BUILDING; BOAT BUILDING PROJECTS; LAND SAILER; PADDLE WHEELER; RACING BOAT; RUNABOUTS; SKIFF, HUNTING AND FISHING; WOOD BENDING.

MATERIALS LIST

Quantity	Size and Description	Purpose
2	2" 4"x8' fir	jig rails
2	2" 4"x36" fir	jig braces
1	1¾" 2½"x9' fir or mahogany	mast
1	1½" 1½"x9' fir or mahogany	gaff and boom
1	1" 4"x8' fir	form brace
1	1" 2"x24" mahogany	stem post
4	¾" 1½"x8' fir or mahogany	chines and sheer
2	¾" 1½"x10' fir or mahogany	frames
1	¾" 3½"x8' fir or mahogany	keelson
6	¾" ¾"x48" fir or mahogany	centerboard frame and rails
2	¾" ¾"x5' mahogany	bowsprit
1	¾" 1½"x36" mahogany	tiller
1	¾" 5"x24" fir	bow frame
1	¾" 3½"x10' fir	bow and transom frames
1	½" 4'x8' exterior or marine plywood	forms and seats
1	½" 4'x4' exterior or marine plywood	rudder and daggerboard
2	¼" 4'x8' exterior or marine plywood	sides and bottom
1	⅛" ¾"x8' aluminum bar	fittings
as needed	¾" #8 flat head brass screws	
as needed	1¾" #8 flat head brass screws	
as needed	1" #8 flat head brass screws	
1	52 square feet 4-ounce Dacron canvas	
1	¼"x10' nylon line	
1	¼"x24' Dacron line	
as needed	¼"x3" galvanized bolts and nuts	
as needed	¼"x3" galvanized bolts and wing nuts	

NOTE: Also need ¼" eye screws, ½" pulleys; S-hooks, cleats, grommets, oarlocks, turnbuckles and lift handles.

Servicing Your Car's Automatic Transmission

A trip to an automatic transmission shop is always expensive. You can avoid one by servicing two simple parts with inexpensive tools. All it takes is about an hour's work every 12,000 miles

THERE ARE THOUSANDS of automatic transmission specialty shops throughout the country, very busily rebuilding automatics at about $300 each. By giving your automatic some very simple care—a form of tune-up—you can greatly extend the life of your unit and hopefully avoid an overhaul for the life of the car.

Nearly 80 percent of the automatic transmissions on late-model cars have replaceable oil filters. More than 75 percent have vacuum devices—called modulators—that play a major part in the shift quality of the transmission. These two items, along with transmission oil, are the things that you can attend to, to keep your automatic in good condition.

The transmission tuneup should be performed at 24,000 miles, and once a year thereafter or 12,000 miles, whichever comes first.

The only tools you will need are ordinary hand tools, a good jack, a pair of safety stands and on Ford products, an inexpensive special wrench for the vacuum modulator.

You can buy a transmission oil filter from most parts houses, as independent filter manufacturers market them. The same is true for vacuum modulators.

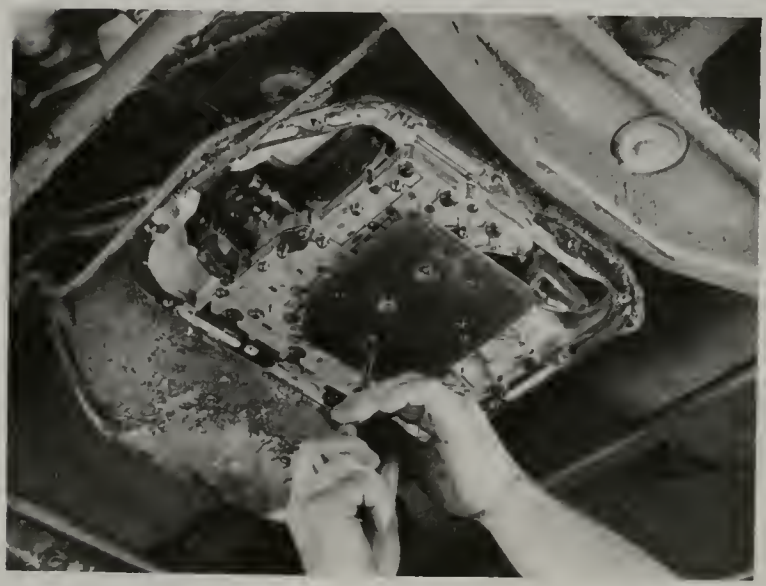
General Motors automatics have replaceable filters and vacuum modulators. Ford products have replaceable vacuum modulators and one transmission has a replaceable filter (the C-4 unit). Others have cleanable screens. Chrysler products have replaceable filters, but use mechanical linkage instead of vacuum modulators. American Motors cars have modulators and cleanable screens.

Start the job by dropping the transmission oil pan, which is held by screws. If the transmission has a replaceable filter, the filter container also will have a pan gasket. If the transmission merely has a cleanable screen, you should buy a replacement gasket before you start the job. (One cautionary note: because there is no drain plug in the oil pan, some care is necessary to avoid

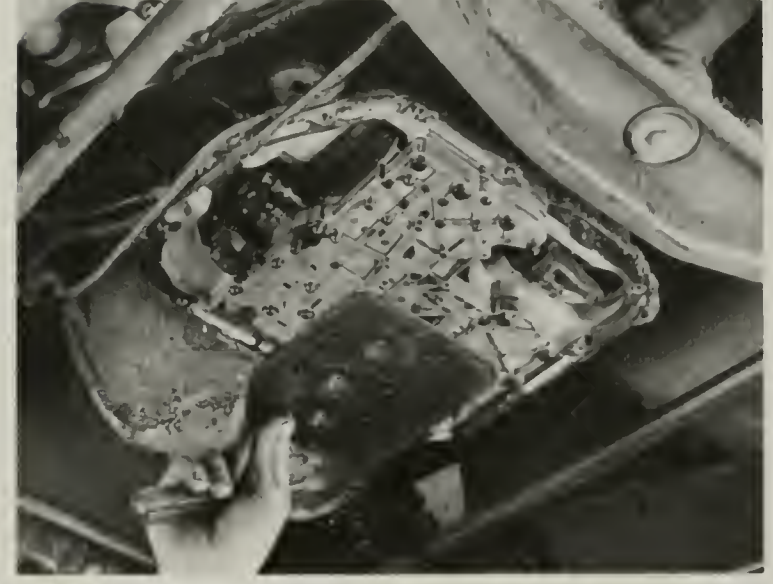
transmission, voice: see laser
trapshooting: see shooting

Job of installing a replacement transmission filter starts with removal of oil pan bolts. Remove rear bolts and work crisscross toward front, so pan will tilt down from the back and drain into the drain pan.

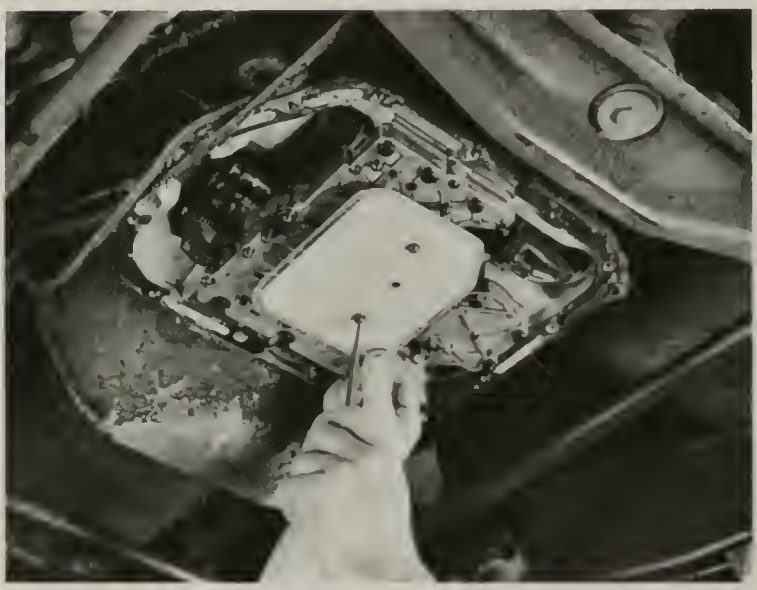
Pan will contain bits and pieces of gasket, sludge and metal shavings. Clean pan thoroughly with solvent. Scrape old gasket off.



Old filter sits just under transmission valve body. It will be held by screws (as shown), or perhaps by clips.



➤ *Once screws or clips are disengaged, pull old filter straight down. If there is a connecting pipe, it will come too. If an O-ring is used on pipe, make sure that it comes out with it.*



➤ *Install new filter. If there is a connecting pipe with O-ring, the new assembly will have it.*

➤ *If any parts of old oil pan gasket stuck to transmission, scrape off with gasket scraper or putty knife. Do not use screwdriver as it could damage the gasket surface of transmission, which probably is aluminum and easily scored.*

spilling oil all over the place when you drop the pan.)

Get the largest pan you can find and put it directly under the transmission oil pan. Undo the rear pan bolts first and then work evenly toward the front so the pan will tilt slightly down from the rear, allowing much of the oil to spill out from there, into your drain pan. (If the transmission oil pan gasket sticks to both pan and transmission, you'll have to free it.) About three quarts of oil will come out.

Remove old filter. With the pan off, the filter is readily accessible. On most cars, it is retained by a few screws. Remove them and pull the filter straight down.

On a few cars, the filter is held by a clip, which either must be removed or twisted aside for filter removal.

Many filter assemblies have an O-ring on the neck that connects the filter to an oil tube or gallery. If the O-ring sticks when you pull the filter down, be sure to remove it. The replacement filter has a new O-ring already fitted to the neck.

If the old transmission pan gasket sticks to the bottom of the transmission, scrape it off. (Caution: many transmissions are made of aluminum and care should be exercised to avoid scoring the transmission's gasket surface.) A gasket scraper or putty knife should be used, not a screwdriver or chisel.

If there are grooves in the pan's gasket mating surface, they should be cleaned with a wire brush. Don't use a screwdriver or chisel, and don't use that wire brush to buff the transmission's mating surface.

Always clean the interior of the transmission oil pan with a general duty automotive solvent and wipe it dry before installing the new filter.

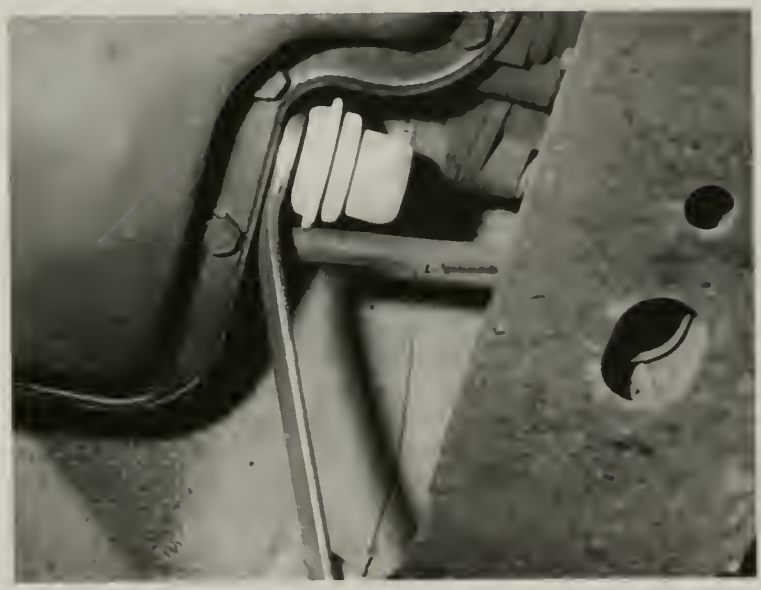
New filter. Installing a new filter is a simple matter of slipping it into place, screwing it down and/or attaching the clip and making sure the O-ring is seated (no real problem).

If you have a 1967 GM car, you should be very careful to obtain and install the

▲ *Apply light coating of white grease to oil pan gasket surface to hold new gasket, which comes with filter. You may use a flexible sealant instead of grease. Never apply grease or sealant to the transmission gasket surface, only to the pan surface.*

➢ *Fit gasket onto oil pan surface. If gasket has dried out, it may have shrunk. The only way to save it is to soak it in warm water. Never try to stretch a dried-out gasket or it will probably break.*

➤ *Replacing a transmission modulator is easy, once you find it. You can identify it by vacuum hose on its neck and cylindrical shape. To replace, first take off vacuum hose. Check inside of hose with pipe cleaner and if you find oil, replace hose.*



➤ *To remove old modulator or install new one, you need a thin wrench on most Ford products. On larger Ford products, a very thin wrench, bent slightly as shown, will get in on the nut.*

➤ *On smaller Fords, you may not be able to get to modulator even with thin wrench. In this case, you can buy inexpensive crowfoot-style wrench designed specifically for the job.*

correct filter, as two different types were used this year, on the following models:

Buick (full-size) with Super Turbine 400
Chevrolet with Turbo Hydra-Matic
Cadillac except El Dorado
Oldsmobile (full-size) except Toronado
Pontiac (full-size) with Turbo Hydra-Matic
Pontiac GTO with Turbo Hydra-Matic

The early filter had a bypass valve and carries original equipment part No. 557-9822. The late filter has no bypass valve and carries part No. 6437741. (Note: the bypass valve was eliminated from the late-1967 filter to force replacement when it is completely clogged. If completely stopped up, the filter can be responsible for transmission growling, slipping and even a no-drive condition.)

The two filters are physically interchangeable, but the replacement must be the same type as the original or the filter may be crushed by the pan or cause transmission damage.

On cars with cleanable screens dunk the screen in solvent, agitate for a few minutes, then remove, shake out excess solvent and allow to air-dry for half an hour.

Refit the transmission oil pan with a new gasket. To simplify installation, a flexible sealant can be sparingly applied to the oil pan's gasket surface (never to the transmission itself).

Modulator. Tighten the pan screws evenly in a crisscross pattern.

Next, while the car still is up on safety stands, replace the vacuum modulator on cars so equipped. A new modulator will smooth the shifting.

You can identify the modulator by ordering a new one for your car and finding the equivalent on the transmission body somewhere underneath. It will have a vacuum hose attached to it.

To replace the modulator, simply pull off the hose and unscrew the unit. This is a simple and obvious job, but you can run into a wrench clearance problem on Ford products.

The modulator screws directly into the transmission, and on Ford products the hexagonal nut that permits removing and installing the modulator is flush with the transmission. An ordinary wrench is too thick to fit in.

The solution is to use a very thin wrench (the wrench size is ¾-inch) if you have one, or buy a special wrench made for the purpose. It is thin, C-shaped, and costs just a few dollars at auto parts stores.

Add oil. Now you are through underneath. The job is finished by topping up the transmission with oil and adding a can of "sealer" through the dipstick hole.

Make sure you use the correct oil for your transmission. The wrong oil can severely damage a transmission. All Ford products should be topped up with a fluid that is labeled "F-M2C33F, suffix 2P." All GM, Chrysler and American Motors cars should use fluid labeled "Dexron."

The topping up should be done on a level floor. The engine should be running and the shift lever should be in neutral on Chrysler and American Motors cars, and park on Ford and GM cars.

Check level. After the engine has been running for five minutes, cycle the transmission. That is, apply the brakes and move the shift lever into all positions, ending up in the position necessary to check fluid level. Then recheck the fluid level.

The "transmission sealer" is not really a sealer. It is a chemical designed to keep the seals supple, preventing them from shrinking and allowing oil to leak out.

When you reinsert a transmission dipstick to check level, be sure it is seated fully. Many dipsticks require twisting to seat, and will give false reading if not fully installed.

See also: ENGINE; FILTERS; OIL, ENGINE; PARTS REPLACEMENT, ENGINE; TUNE-UP, ENGINE.

How to Repair a Trash Compactor

Compacted trash is easier and cheaper to dispose of than loose trash. These simple machines do the compressing job with a one-ton squeeze

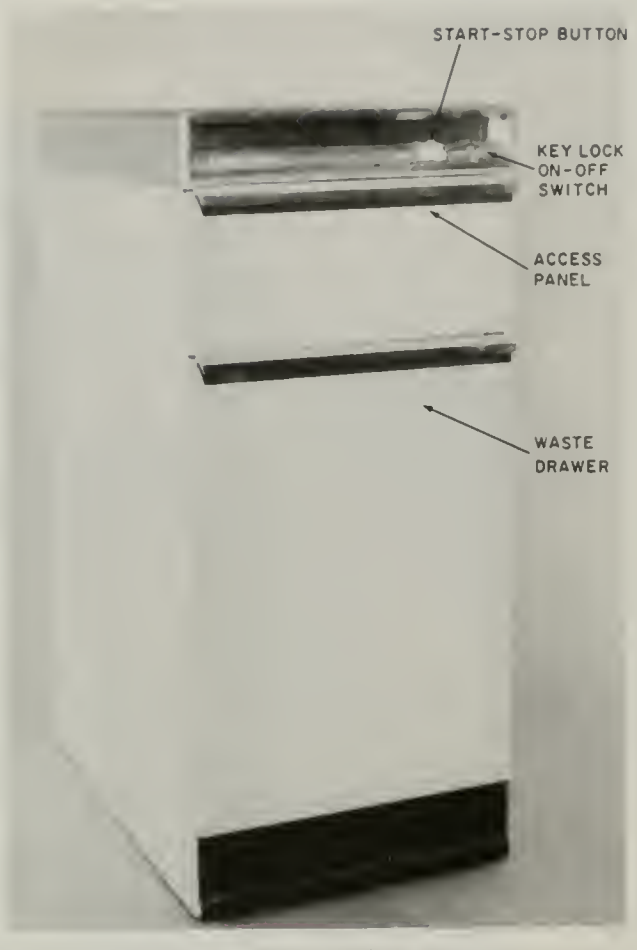
THE COMPACTOR is an appliance designed to reduce the volume of trash and prepare it for refuse pickup. It will accept cans, bottles, cartons, paper and garbage, although garbage is better handled by a disposer.

Installation. The compactor can be located where convenient, provided the floor is secure and the leveling legs have been adjusted to insure that the compactor is level and set firmly on the floor.

It requires a 120 volt, 60 Hz AC electrical outlet with a provision for a grounding terminal.

Operation. Trash is thrown into the machine through an access door. Compacting action commences when the start button is activated. A motor screw drives the ram about 2/3 the way into the container drawer or basket to compress the waste. It then moves upward to its original position. As the container fills, the ram will travel until it exerts about 2,000 pounds of pressure. Then the motor automatically reverses to retract the ram.

If the ram should jam on the downstroke, owing to some object being wedged between the ram and the container, momentarily depress the stop button. Then push the start button again. This reverses the motor to pull the ram up and allow for repositioning or removal of the offending article.



To open the waste drawer of this trash compactor, tilt up slightly on the handle and pull it out to its stop position. The waste drawer must be halfway open before the access panel is opened.

Cleaning. Cleanliness is important. The outside of the compactor can be cleaned as you would any other appliance. The inside can be cleaned after removing the trash container. For one typical unit, simply removing the refuse container will provide room enough to clean. For other units, the drawer can be removed by pulling it all the way out to its stop position. Then push down on the drawer release tabs which are located on each side of the drawer near the cabinet bottom.

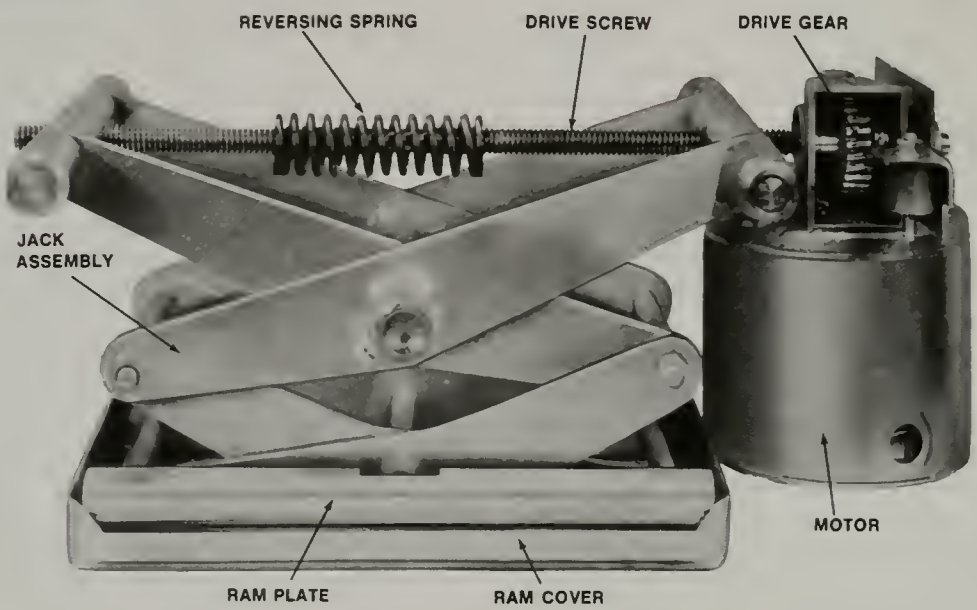
The ram and other inside areas that have been exposed to trash can now be cleaned with detergent and water. Then they can be

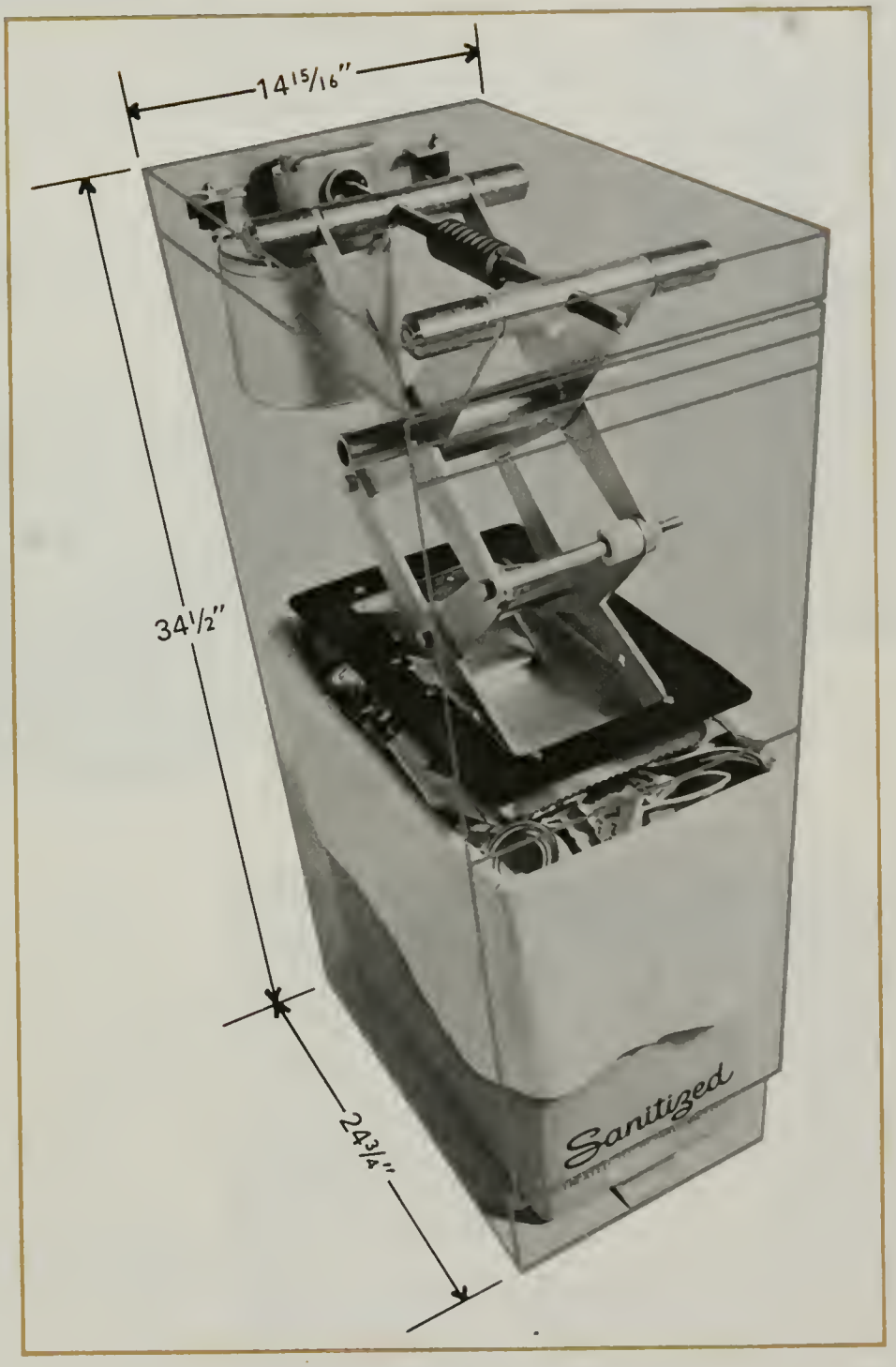
travel trailers: see campers

How to Repair a Trash Compactor

In this trash compactor, the access door is opened to remove compacted trash. The device is loaded through a smaller tilt-down loading panel in the access door.

Tha motor, jack and ram assembly of an In Sink Erator trash compactor in the retracted position.

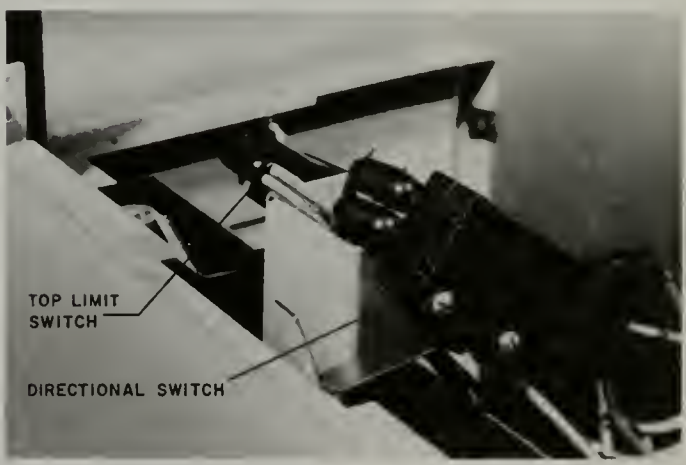


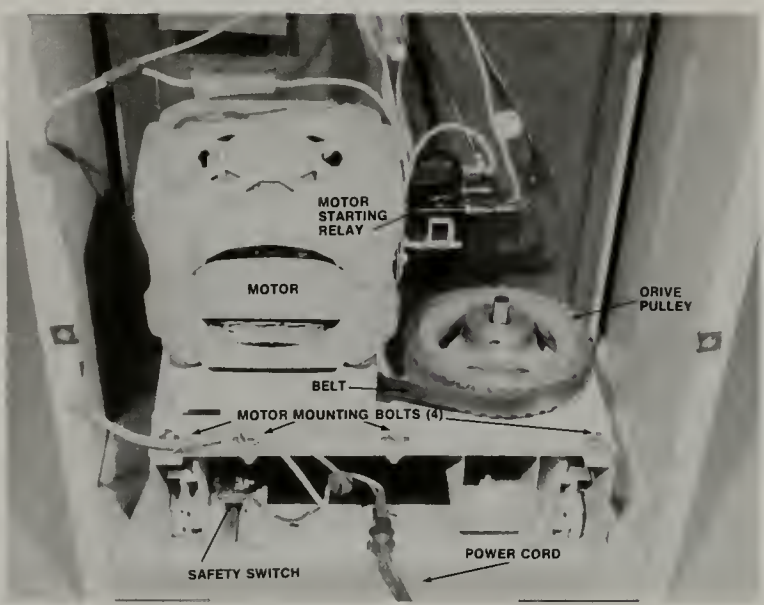


▲ *Scissors jack action transforms motor power into ram pressure for trash compaction.*

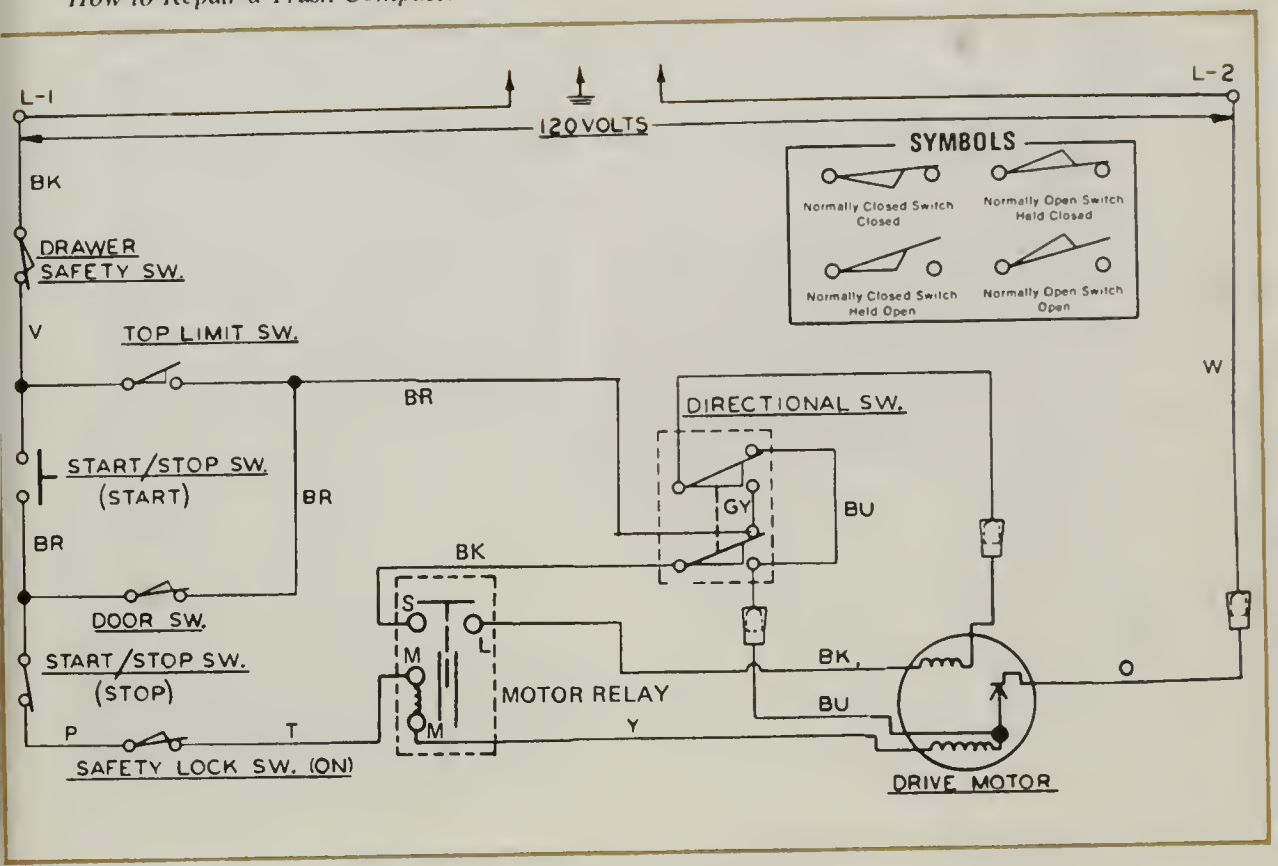
This Whirlpool trash compactor uses two screw jacks, one on each side, to move ramp up and down. The screw jack and its mate on the opposite side are turned by a chain drive. The chain and sprockets are accessible from the bottom of the machine.

The top limit switch and directional switch of this compactor are mounted above the ram. The top limit switch shuts the unit off when the ram returns to the top of its stroke. The directional switch changes the direction of ram travel at the bottom of its stroke.

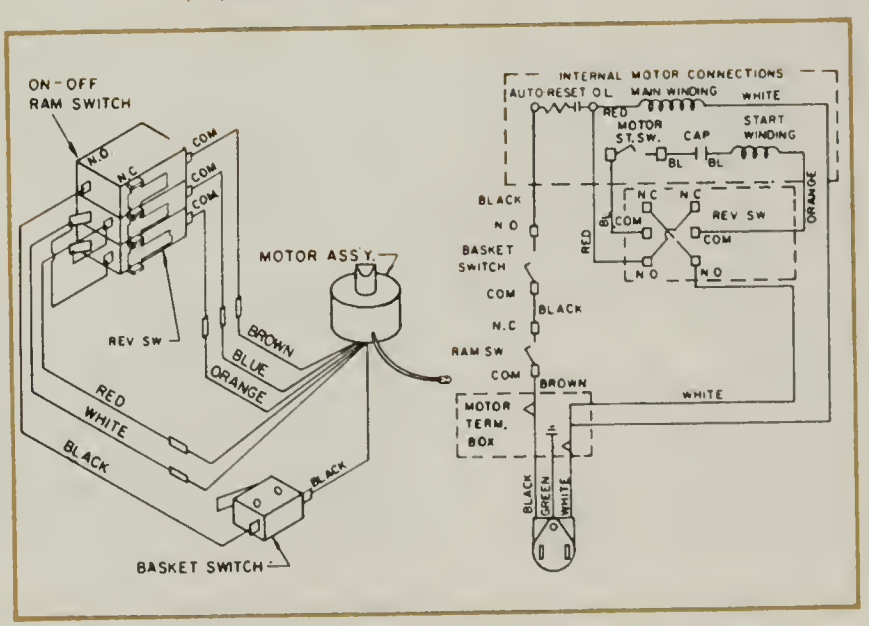


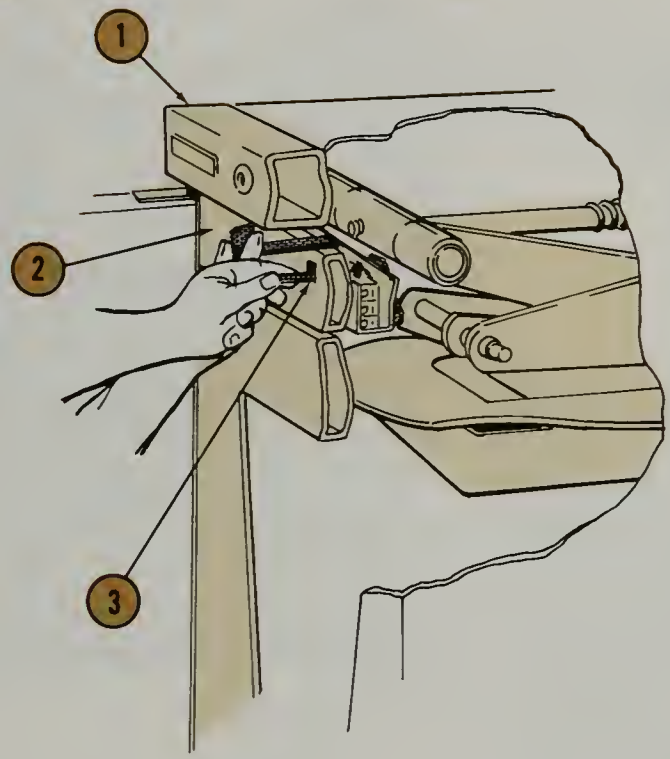


Whirlpool trash compactor motor and drive assembly are reached by removing the rear panel. Adjust belt tension by loosening the motor mounting bolts and sliding the motor to achieve 1/8-inch belt deflection.



▲ *Typical trash compactor wiring diagrams.* ▼





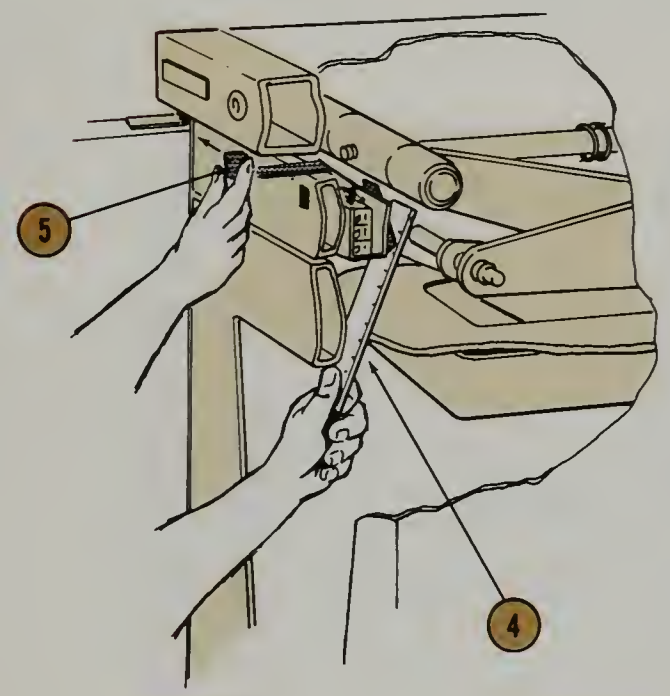
The necessity of manually pressing the ram lever switch is brought about by the ram having traveled down far enough to open the "down" cycle switch, but not far enough to close the "up" cycle switch. When this condition occurs, the latch lever can be moved to the extreme left position to close the on-off switch, but the unit will hum only and will not run because only the run winding is being energized. To activate the unit, it is necessary to manually press the ram lever switch to close the start winding circuit, at the same time moving the latch lever to the far left position to activate the on-off switch. The motor will then run and the ram will start downward. To accomplish pressing the ram lever switch, proceed as follows.

Remove electrical plug.

Open both doors.

Leave basket in compactor.

Insert an object such as a 12" wooden ruler into the opening between the rubber ram wiper and the front of the cabinet at the area marked (4). Press towards yourself and listen for the switch to "click" to assure that you have the ruler located properly. After you have located the switch properly, proceed as follows.



Install electrical plug.

Directly below the control panel (1) is a trim panel (2) retained by two screws, one at each end. On the right side of this trim panel is a vertical slotted opening (3) approximately 1/4-inch wide by approximately 3/4-inch long. Insert a wooden pencil, or other non-conductor of the same size, into opening and press in. This will activate the loading door safety lever and will then allow you to move the latch lever to the center position.

Again insert the ruler into the opening between the rubber ram wiper and the front of the cabinet (4). Press the ruler towards yourself, at the same time moving the latch lever (5) to the far left position. The unit will start and the ram will proceed to travel down. As soon as the unit starts, remove your hand and the ruler quickly. The ram will make a complete cycle, return to the retracted position, and then shut off. Move the latch lever to the far right position, close the doors and the unit can then be operated normally.

disinfected. The cleaning process will have to be done more frequently if any amounts of unwrapped garbage are added to the trash.

For your safety it is advisable to disconnect the compactor from its electrical outlet while you are working on the unit.

Service. Most service work can be performed by either removing the drawer or container, or by removing the rear service panel.

The wiring diagrams show the interlocking safety switches, reversing switches and the motor connections. These diagrams may be used for reference but, as with other major appliances, there should be a wiring diagram for your model attached to the back panel. Use that diagram.

As with all electrical appliances, make certain that voltage is available to the machine. This test should be made with a voltmeter at the machine end of the power cord. If voltage is available there, the safest thing to do is to disconnect the power cord from the wall outlet and test each part with your ohmmeter for proper operation. Follow each circuit and test it from point to point. The motor windings should show continuity and a switch will change from 0 (zero) to ∞ (infinity) reading as it is turned on and off.

Pay particular attention to the limit switches. These switches only operate when all moving parts, drawer, basket, ram, etc., are in their correct position. That is, when all switches are making firm contact to the switch actuating lever. Either the switch or the part may be out of position. Check the moving part first.

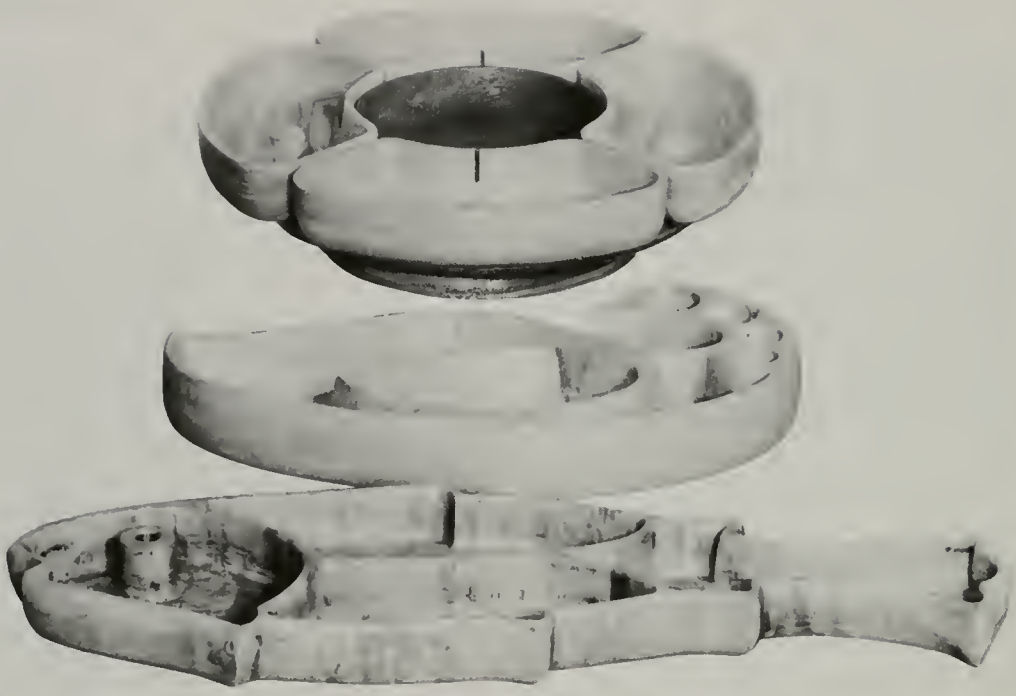
Most of the electrical parts on some compactors are accessible from the rear. The door switch is located above the drawer opening behind the front frame.

Service parts for the compactors are available through the local dealer for the particular make and model you have. G.M.

See also: APPLIANCE REPAIR; ELECTRICITY; INDIVIDUAL APPLIANCE LISTINGS.

TRASH COMPACTOR TROUBLE-SHOOTING CHART

PROBLEM / POSSIBLE CAUSE	NO POWER	SAFETY SWITCH OPEN	DEFECTIVE SWITCH	LOOSE CONNECTION	MOTOR OVERLOAD TRIPPED	BLOWN FUSE	LATCH HANDLE STUCK	LOOSE PART VIBRATION	DRIVE GEAR, CHAIN, BELT	DRIVE SCREW DRY	RAM STUCK PART WAY	TOO FULL	SPOILED FOOD IN CONTAINER	INSUFFICIENT DEODORIZER
WILL NOT RUN	√	√	√	√	√	√								
STARTS, THEN STOPS		√	√	√	√	√								
RAM RECYCLES			√				√							
NOISY OPERATION								√	√	√				
CONTAINER STUCK		√	√	√	√	√					√	√		
BAD ODOR													√	√



How to Make Wood Trays and Lazy Susans

These wood projects are ideally suited for the home workshop, and they make fine gifts for friends

WOOD TRAYS AND LAZY SUSANS are always welcome gifts and are especially adapted to home shop production. Two or three copies of the same design may be bandsawed at one time, and one drill press or other machine setup will serve for all, reducing setup time per unit. Even if the trays are made by hand, they can be shaped with relative speed, using rasps and files.

The best materials for trays are medium-firm hardwoods such as mahogany, prima vera, or ash. Birdseye or curly maple makes up beautifully but is so hard to work that a considerable investment of time is required. Choose 2-inch stock, utilizing all the thickness. Rough lumber yields the greatest depth. Surface it, removing as little wood as possible.

Trays. As a first step in making a tray, sketch the design on a grid of penciled squares and transfer to the wood with carbon paper. The size is regulated by the dimensions of the squares drawn for the grid. (Trays tend to look bigger than expected when made up.)

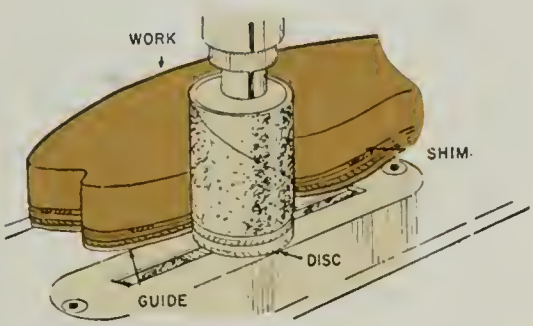
The average bandsaw will cut three thicknesses plus a ¼-inch plywood pattern to be used for truing the edges. Nail the pieces together, driving finish nails through waste corners, and brad the plywood on top. Trace the pattern on this. Bandsaw the stack. If nails are well placed, the pieces will stay in alignment until the sawing is complete.

Smooth the edges of the pattern and brad it to the underside of a piece with ⅛- or ¼-inch shims between to lift the work a little above the lower end of a sanding drum. Mount the sanding drum in a drill

tree root clogging: see drains

press and bolt a ¼-inch plywood disk of the same diameter to the table, centering it on the drum. Sand the edges by sliding the pattern along the disk, so regulating the depth of cut. The inside angles that are not entered by the drum are smoothed afterward with files.

Rounding of the edge can be approximated with shaper cutters, but the finishing touches are applied with hand work. A 10-inch patternmaker's rasp, followed by ordinary wood files, makes this a quick job, although a wood file alone will do it. Sanding time is reduced if a fine-toothed bastard or even a mill file is rubbed along over the shaped edge before garnet paper is used.



Using the pattern while drum-sanding edge.

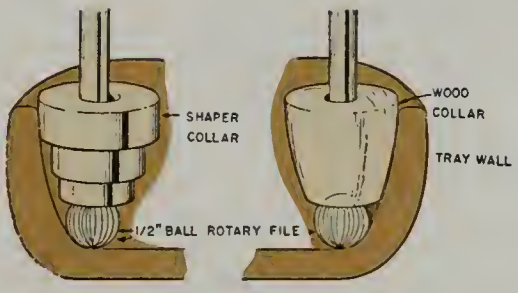
Trace the pocket outlines onto the pieces, correcting the outer edge thickness by gauging with a lead pencil, with your fingertips sliding along the edge. Rough out with a boring bit in a drill press. A flat bit with the center point ground down to project equally with the lips cuts fast and runs cool. It can be set with the depth gauge to bore within $\frac{1}{16}$-inch of the finished bottom. Knock out the webs with a gouge.

Smoothing of the walls is done with a rotary file nearest the desired profile, such as a tree-shape with a radius end. Lock the quill at a point where the tip of the file clears the bottom about $\frac{1}{32}$-inch and plane the pocket sides freehand, feeding against rotation with light, rapid cuts. Rough places can be spotted by setting up a lamp to shine along the side being worked.

After side truing, fillet the bottoms, using a ½-inch ground-tooth burr. The problem here is to make a cut tangent with the side. Slip small shaper collars over the shank of the file, the upper one being large enough

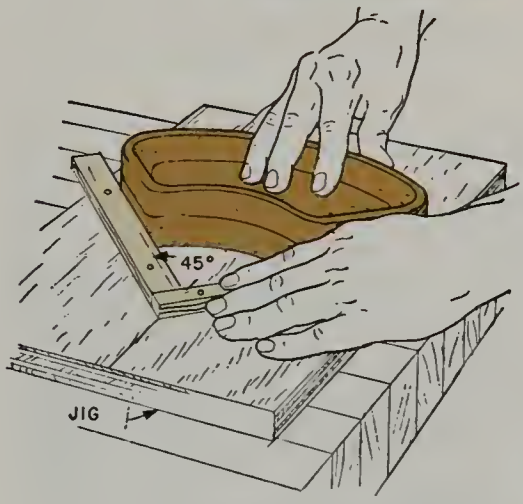
Turning a lazy Susan base.

Splitting off backing block after sanding.



Use shaper collar or wood collar to fillet.

Scribe circles to locate screws for bearing.



Jig simplifies the fitting of tray ends.

to bear against the side at the top. The collar holes can be larger than the shank.

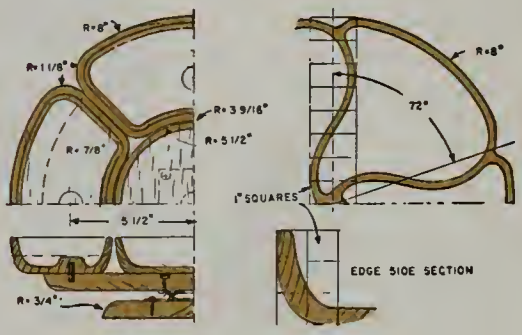
If no collar is available, make one of hardwood. Set the depth gauge to bottom the file ¼-inch from the table, and with the machine running, lower the file and lock the quill. When the collar contacts a side, feed the cutter along. This rotary file also will level the bottoms of the pockets but a router-bit is faster working. Be careful not to gouge the sides.

Parts inaccessible to the rotary files can be reached with bent-handled rifflers and with strips of sandpaper drawn over the end of a rounded dowel stick. Sand the trays thoroughly.

Before finishing it's a good idea to letter or type a neat label to stick on the bottom of each tray, mentioning the kind of wood and warning against immersing in water. Advise wiping with a damp cloth after using, drying, and rubbing all over with a cloth moistened in salad oil.

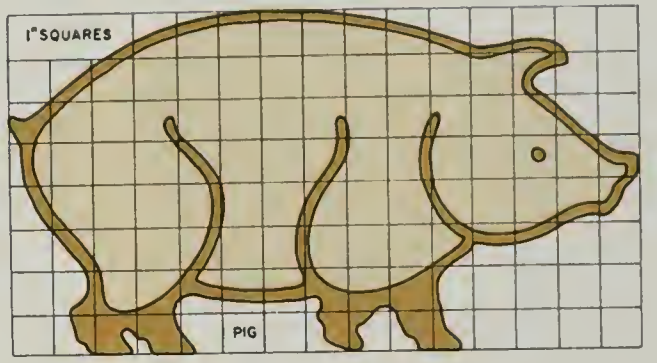
A satisfactory finish is four coats of clear brushing lacquer, with 2 hours drying time allowed between coats. Make no attempt to fill open pores.

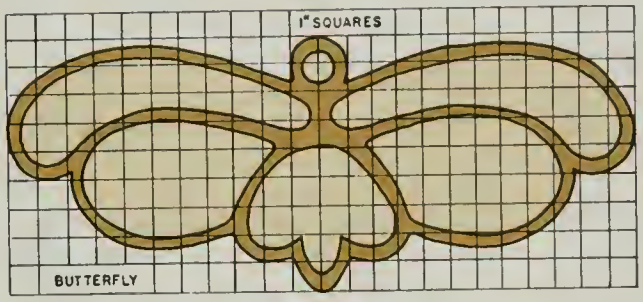
Lazy Susans. A lazy Susan is made in much the same way as the other trays, whether with a single bowl or in separate units. If 2-inch material is not available, use ¾-inch stock. Jig saw the upper walls of a tray, tilting the table to slope the inside, and glue to the bottom pieces previously rough sawed outside to shape. This saves routing time, as only the lower piece

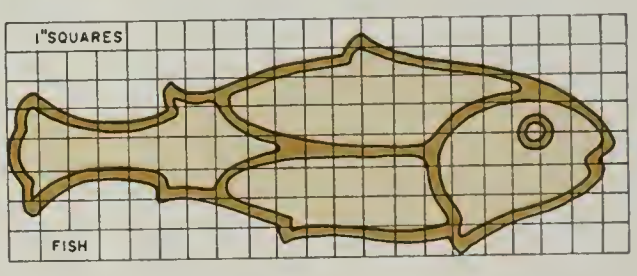


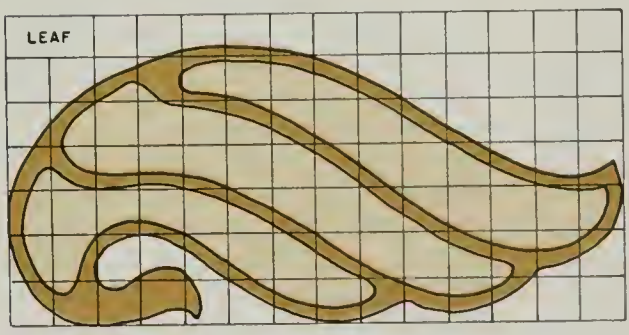
Lazy Susan details.

PATTERNS

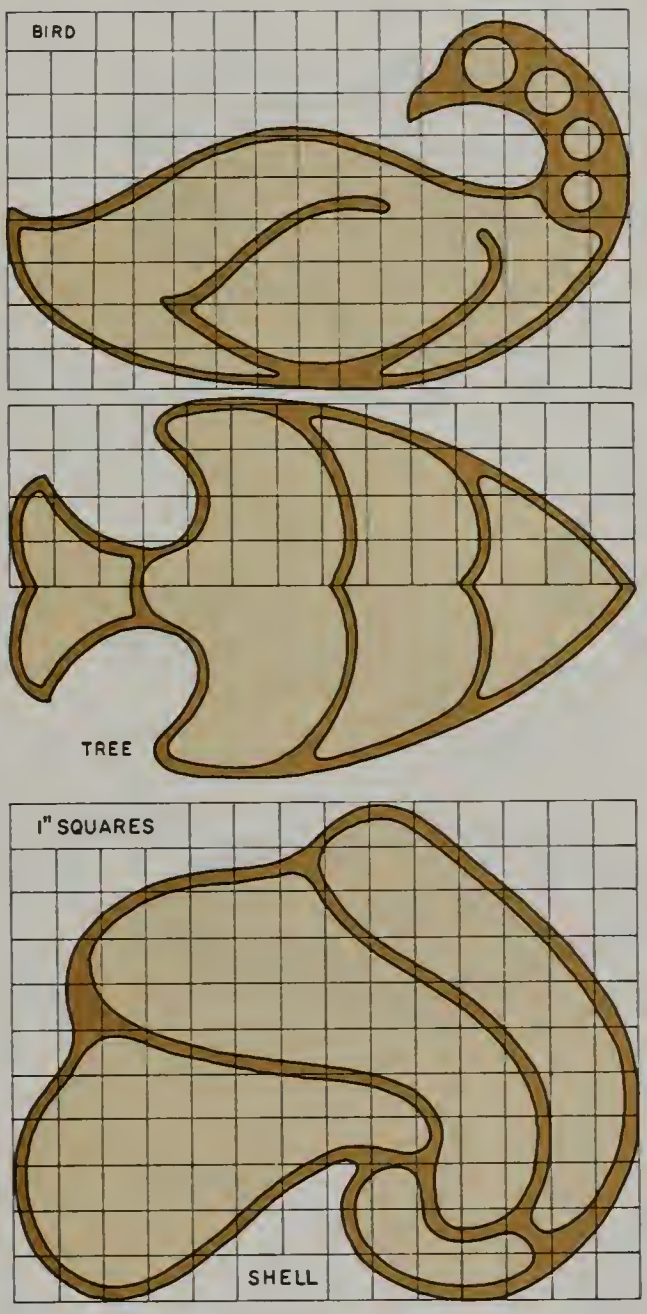








needs to be excavated. Otherwise, the outer shaping and inner smoothing of the walls is done as described for the trays. Note the bosses, which are bored from beneath to receive $\frac{5}{16}$-inch dowel pins set into the turntable to hold the trays on.



Ash and mahogany are good materials for a lazy Susan. For the five-tray type, saw out the mahogany center and glue it to a pine backing block with a sheet of paper between. Screw the block to a face plate, turn the edge, set the tool rest across the face of the tray, and turn the inside. After sanding, insert the edge of a chisel into the joint, strike it a light blow with a mallet to split the paper, and sand the tray bottom.

The use of a jig as shown in the drawing simplifies the fitting of tray ends. Draw a center line on a board, and nail down two straight strips of wood at right angles to each other and 45° with the center line. Scribe an arc between the two centering at the apex of the angle, with a radius of $3\frac{9}{16}$-inch. To true the tray ends, sand them until they contact the strips when the inner edges align with the penciled arc on the board.

The turntable is of two disks which are easily made by sawing and sanding with a pivot jig, followed by edge shaping. They also can be turned. The upper disk must be flat and well seasoned. A piece of $\frac{5}{8}$- or $\frac{3}{4}$-inch ash plywood is excellent, the plies being hidden with a coat of matching paint after the finish is on. The lower member, if made of rough stock, can be $\frac{7}{8}$-inch thick, improving the design.

A 3-inch lazy Susan bearing is the easiest way of swiveling the turntable. The two metal squares are grooved to form races for steel balls, and the center edge of one is rolled over that of the other to hold them together. Scribe centering circles on the turntable pieces to locate the screws, four of which are passed through the larger holes into the bottom. The top is attached with #6 sheet-metal screws passed through holes drilled in the top disk and counterbored to sink the heads flush.

Bore dowel holes in a circle of $5\frac{1}{2}$-inch radius drawn on the top of the turntable, gluing in dowel pins with rounded ends projecting $\frac{5}{16}$-inch. Bore sockets in the trays $\frac{3}{8}$-inch deep. The trays can be adjusted for position and fit by offsetting the sockets with a router bit. E.M.L.

See also: CARVING; CHISELS; DRILL PRESS; FINISHING, WOOD; INLAY WOODWORKING; LATHE; ROUTER; WOODWORKING.

Build a Butler's Tray Table

This dual-purpose unit can serve as either a small table or as a serving tray

HERE'S A NEAT WOODWORKING project that you'll be proud of—a butler's tray table. As the name implies, it serves two purposes—a sturdy table and a handsome serving tray. Special butler tray hinges have no projections and are spring loaded so they will hold in any position. A clever self-centering arrangement on the underside of the tray holds it in place on the base so it cannot accidentally slide off. The unit shown was made of lumber-core birch, but other woods may be substituted. For a colonial look, pine may be used.

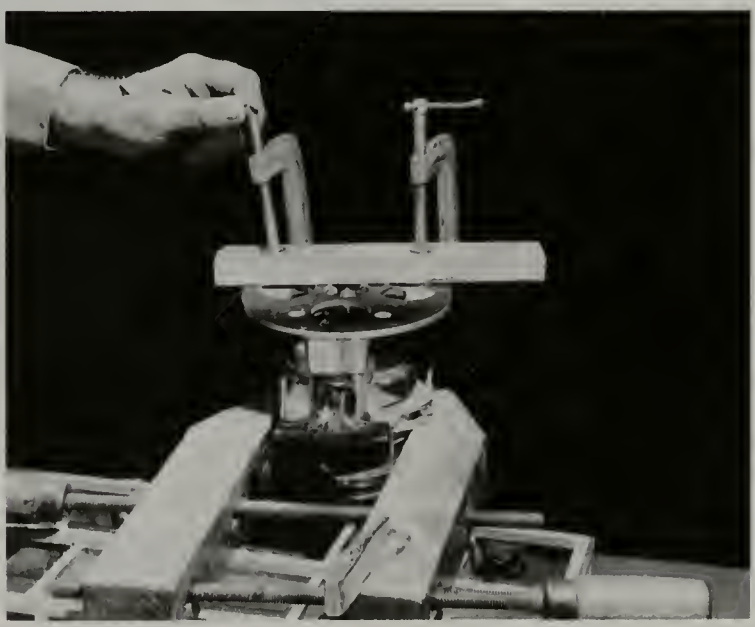
Start with the base. Cut the squares for the legs to size, then clip the diagonal on the table saw. Be sure to place the fence so the waste will fall away from the blade, otherwise a kickback may result.

The legs are now ready to be grooved. This can be done either on the shaper, if you have one, or with the router. If the router is used, it would be best to mount it inverted on a table, as shown. This converts it to a mini-shaper and makes it much easier to use. Insert a "V" cutter in the router collet and set the proper depth of cut. Cut should be ⅛-inch deep. A makeshift fence consisting of a small piece of wood and a couple of clamps will do. Set the fence so the cut is ⅜-inch in from the edge of the work. Run the work through, then change cutters and round off the three corners shown. If your cutter has a pilot, you will not require the fence.

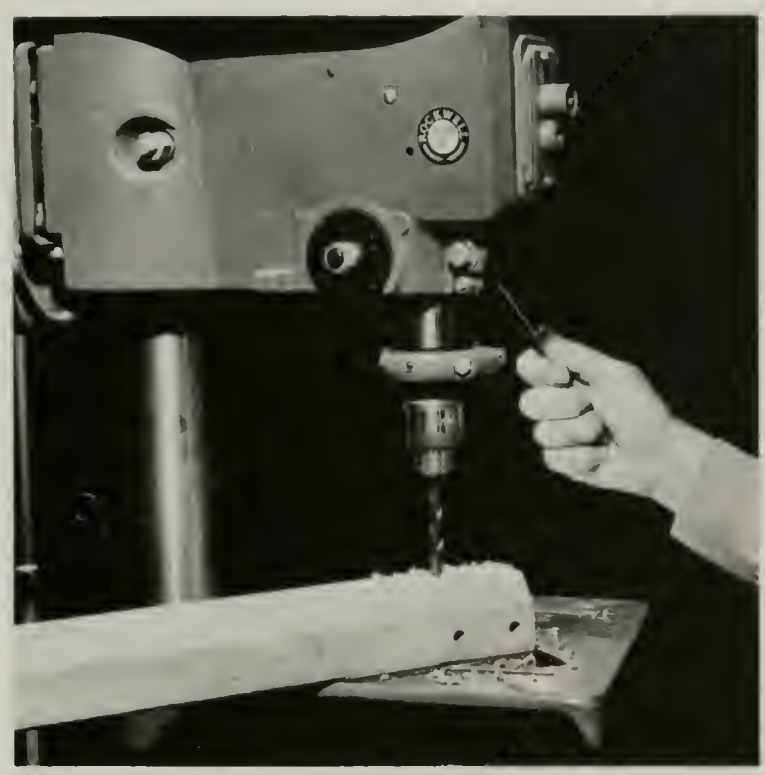
Rails for the table are cut to size and drilled to take two ⅜-inch dowels. Dowel transfer points are used to locate the holes. Prop up the work as shown for proper alignment. Center punch the prick marks left by the points, then proceed to drill the holes for the dowels. The depth of the holes should be $1\frac{1}{16}$-inch. Insert dowels with glue and assemble the base.

When ripping the diagonal for the legs, it is best to set fence on the proper side to insure maximum safety.

Dowel points are used to transfer hole positions from rails to legs. You should work on a flat surface and be certain to align the pieces with great care.



A simple conversion turns the router into a mini-shaper. This will be used to groove the legs. The inverted position, as shown here, will make it much easier to work with small pieces.



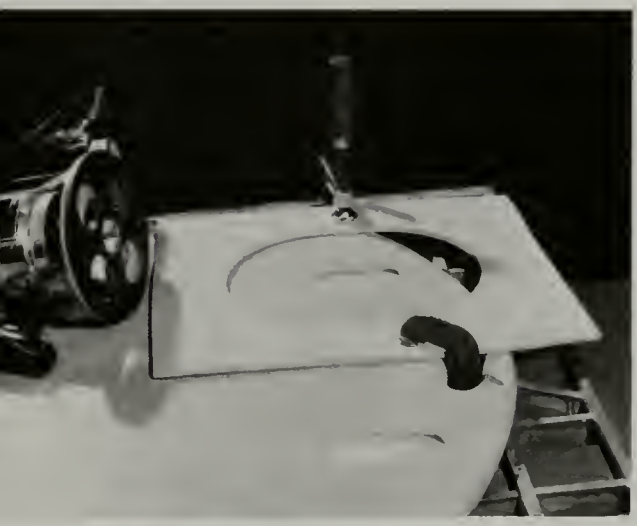
Accuracy makes drill press ideal for making holes. If you use portable drill, be sure to hold it straight and square.

With top cut, place the base in position and center carefully. Mark off inside edges of the rail and then slowly cut along the guide.

The aligning jig on the underside of the top is made with rounded corners which cause the tray section to "fall" into place on the table.

2868

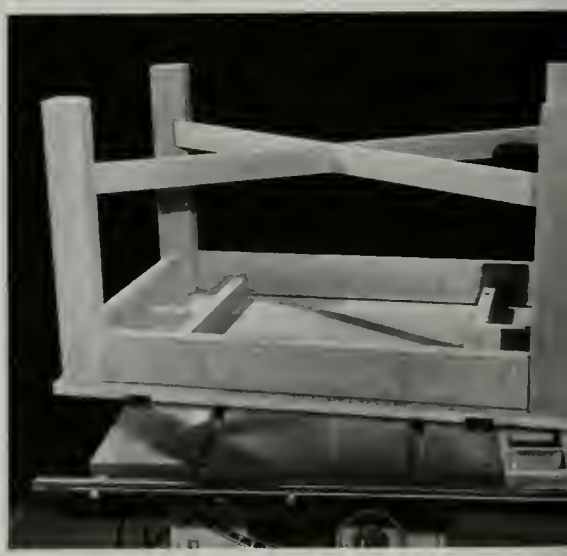
Build a Butler's Tray Table



The easy way to mortise hinges is shown. The plywood jig will yield perfect results every time. Center lines on jig simplify alignment.

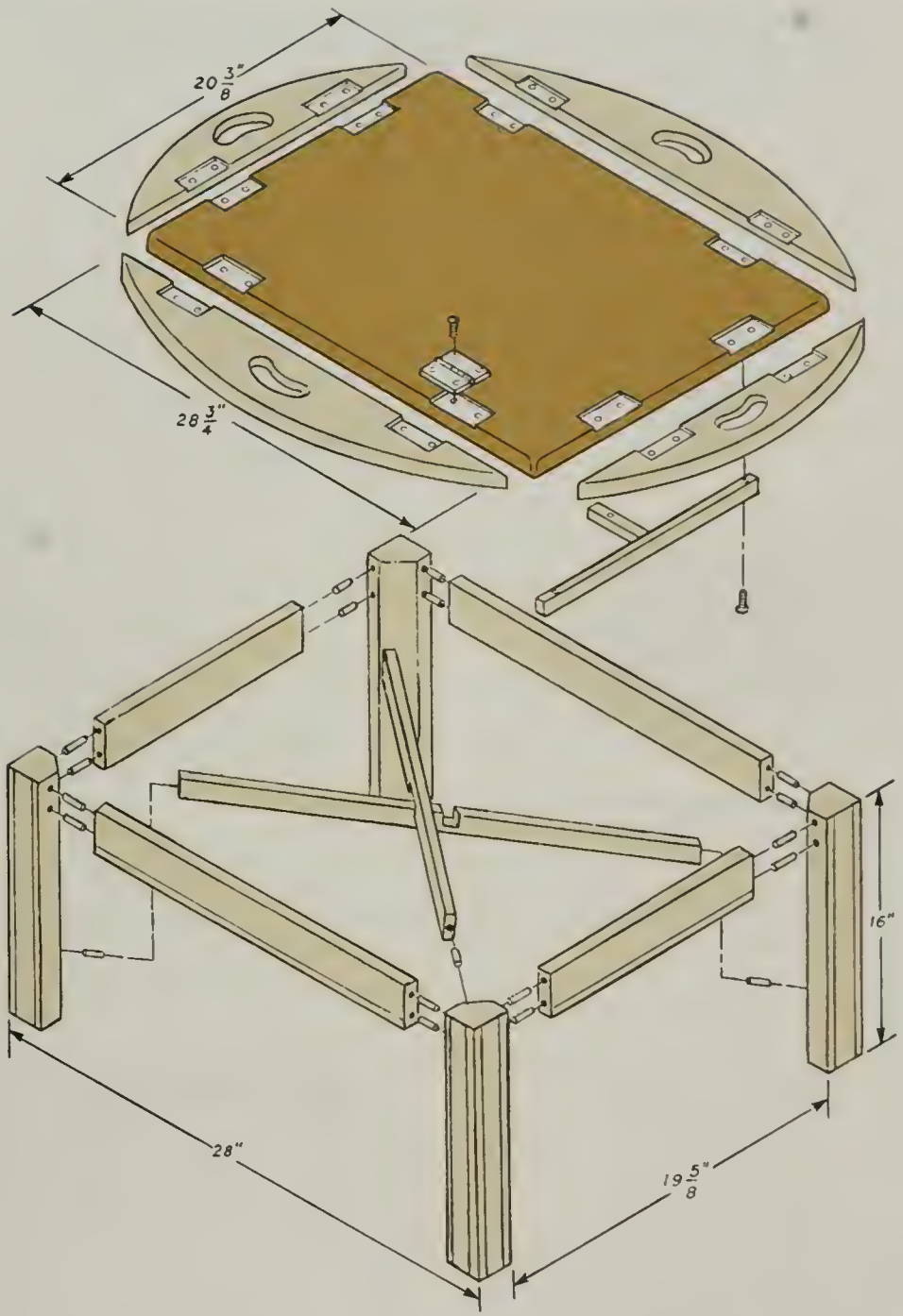
Although other types of wood such as pine may be used for the project, one advantage of lumber core plywood is that the edge can be easily sanded.

The photo shows one hinge mounted and another ready to be. Note shims that make up for thickness differential.

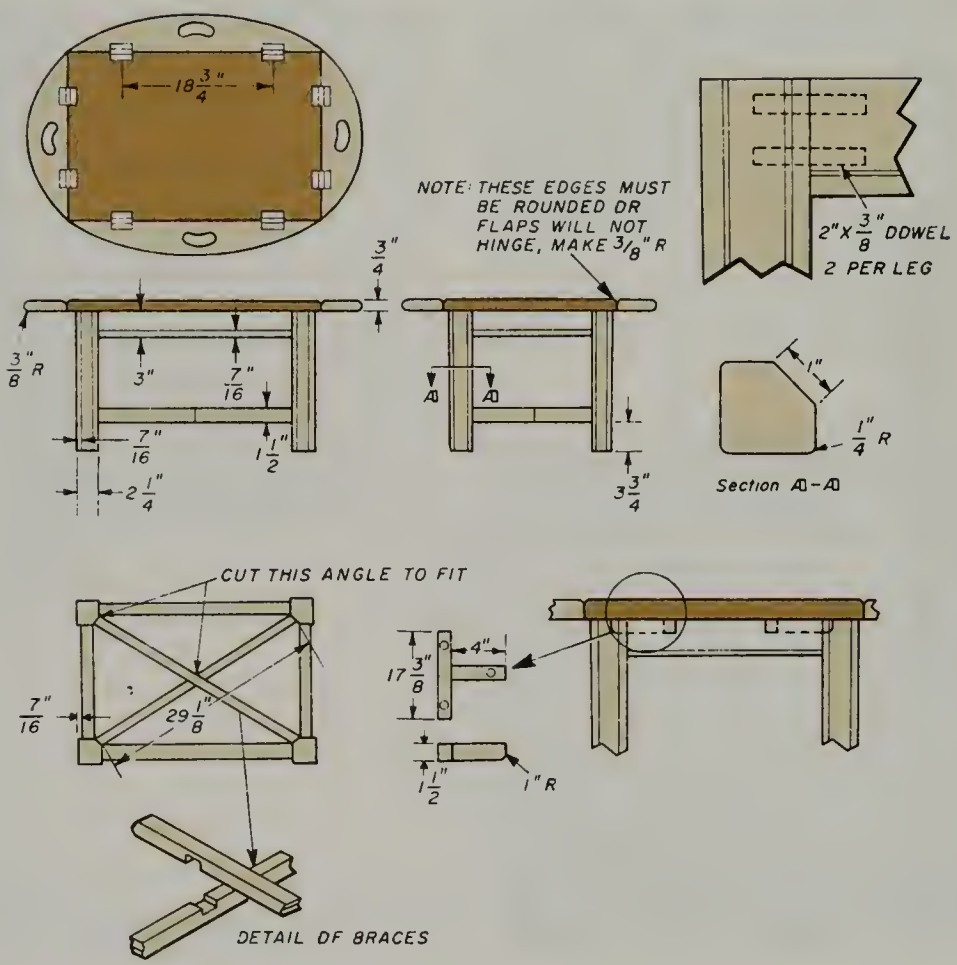


Underside view of the table with flaps removed. It is ready to be finished.

Build a Butler's Tray Table 2869



The top board is prepared next. If your table saw fence will not extend far enough, try this. Clamp a strip of wood to the underside of the work, then use the edge of the table as a guide. Place the assembled base on the table top and carefully center


18 3/4"
NOTE: THESE EDGES MUST BE ROUNDED OR FLAPS WILL NOT HINGE, MAKE 3/8" R
2"X 3/8" DOWEL
2 PER LEG
3/4"
3/8" R
3"
7/16"
7/16"
1 1/2"
2 1/4"
A
A
3 3/4"
1"
1/4" R
Section A-A
CUT THIS ANGLE TO FIT
7/16"
29 1/8"
17 3/8"
4"
1 1/2"
1" R
DETAIL OF BRACES

Build a Butler's Tray Table 2871

MATERIALS LIST

Quanlity	Size and Description	Purpose
1	3/4" 20 3/8"x28 7/8" red birch	top
2	3/4" 4 3/4"x28 3/4" red birch	flaps
2	3/4" 4 3/4"x20 3/8" red birch	flaps
2	3/4" 3"x23 1/2" red birch	rails
2	3/4" 3"x17 1/8" red birch	rails
4	2 1/4" 2 1/4"x16" red birch	legs
2	3/4" 1 1/2"x29 1/8" red birch	stretcher
as needed	1 1/2" #8 round head screws	
as needed	3/8"x2" dowels	

NOTE: Also need butler tray hinges and finishing materials.

it. Next mark off the jig which consists of four cleats, two long and two short. They are cut so they will be a trifle smaller than the inner dimension of the rails. Align and then install.

The curved sides are made next. These can be cut either on the band saw or with a saber saw. After cutting, sand the edges smooth then shape the edge still using the router as a shaper.

The hinges are mortised next. Some butler hinges have half-round ends while others are square. Regardless of the hinge used, a mortising jig made of ¼-inch plywood can be used advantageously. Simply note the distance from the outside of the cutter to the outside of the router base plate. Trace the outline of your hinge onto a piece of ¼-inch plywood, then enlarge the outline by adding the dimension obtained from the edge of the cutter to the edge of the base plate. This will give you an outline of your hinge measuring something like 8 x 14-inches. Cut this out, saving the outside part. This is now a guide for the router and if you will make a trial cut on scrap wood, you should find that the hinge will fit perfectly into the mortise.

The butler hinge is unique in that the leaves are not the same thickness. This means that the mortise will have to be made to the deepest part of the hinge. Shims are made to be placed under the thinner part, as shown. Some butler hinges have the same thickness leaves, so it is recommended that you not mortise for the hinge until you have it in hand. The dimension for the mortise was purposely left out of the drawing.

When mortising, place both the sides and table top in position and mortise them together.

Stretchers are added to complete the construction. Stretchers are glued in place and held with screws driven diagonally.

To finish the table, remove the hinges and sand all parts thoroughly. Then finish to your liking. Antique red (with the base coat thinned so the rich grain pattern of the red birch would show through) was used on this tray table. Many finishes are possible, and if antiquing is not your cup of tea, try a wood-tone stain topped off with a French polish. J.C.

See also: BARS; CARTS; DOWELS; DRILL PRESS; FINISHING, WOOD; ROUTER; SERVERS; TABLES; WOODWORKING.

WHERE TO FIND IT

If your local dealer cannot supply them, butler tray hinges are available from the Armor Company, Box 290, Deer Park, N. Y. 11729. Write to them for information.

➤ *Willow adds informal beauty to an otherwise austere landscape.*

What Homeowners Need to Know about Trees

The right tree in the right place adds privacy, beauty and a balanced appearance to your house. Here are tips on how to select and care for trees

SELECTING THE BEST TREE for each use and location is as important as selecting the right workman for home repairs, and the fact that a tree is pretty or thriving in a neighbor's yard is no indication that it will fulfill your needs.

Before making a choice you should have answers to these two questions:

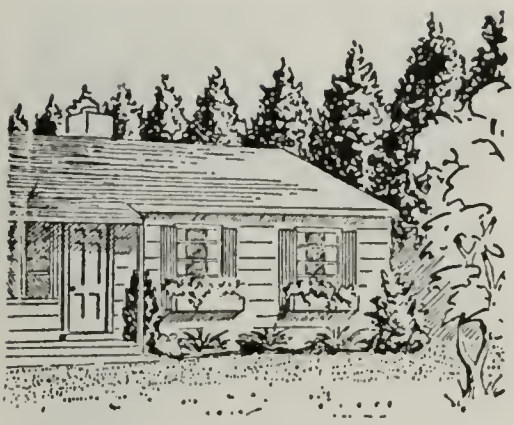
1. What is the primary use?
2. What are the soil and climate conditions?

When you have multiple answers to the first question, rank them in order of priority. Which is most important, shade, privacy, a windbreak, or merely enhancing the beauty of your home?

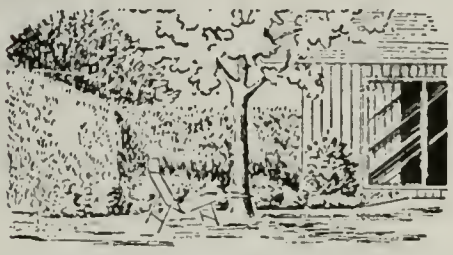
If the primary purpose of a tree is to enhance the appearance of your house, you must study its outside dimensions. Tall trees will dwarf a single story house, yet you will need height around a house with two or more stories. Consider the size of the house in relation to the lot. If it seems to crowd the boundary lines, keep the landscaping low and simple. But where there is a considerable amount of lawn, larger trees may add unity. Trees can also serve dual purposes. A pin oak grown to maturity, for instance, can shade a patio, provide privacy and add to the beauty of the neighborhood, as well.

Also consider shapes that would be most

trees and shrubs: see landscaping
trees, grafting: see grafting
trees, watering: see gardening



Plant spruce or pine as a windbreak to frame a house like a picture.



A clipped hedge of yew, juniper or arbor vitae usually provides maximum privacy and best appearance.

Choose evergreens so that they combine with the house to make an attractive picture.

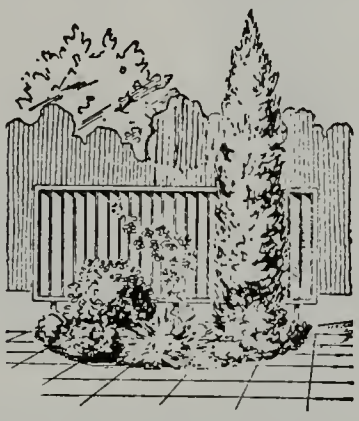
Avoid positions for large-growing plants that will block walks or windows, or make a house look unbalanced.

How trees can add privacy to a home without cutting off light.

Plant trees in groups. Odd numbers usually work best. These Zelkoves illustrate the way a small grouping can add depth and interest to a lawn.

➤ *Globe arbor vitae at entrance and dwarf spreading yew combine for a sense of balance in small foundation planting.*

➤ *Low plants fill out the bed while columnar juniper or arbor vitae can be used to provide an interesting accent for a patio or terrace screen.*



suitable to your site. Would you prefer the informality of a weeping willow or a sourgum, the roundness of a sugar maple, or the slenderness of a Lombardy poplar?

The leaf type and texture will also have a bearing on the appearance of your yard. Evergreens tend to look heavy and strongly weighted to the ground. Elms and locusts have small leaves and are light in appearance. Horse chestnuts and sycamores have large leaves and appear massive.

You may have special needs which will require trees with special characteristics. For instance, a corkscrew willow or an Amur maple is good for a small area where you need shade. White pines and Norway spruce are good screening trees. A redbud, dogwood, or Japanese maple is ideal for adding color and beauty to an area limited in space.

On the question of soil and climate, consider how much sun and rain the tree is likely to get. What is the nature of the soil —is it predominantly sand or clay, or are there lots of rocks in the ground?

Choosing the tree. Consider evergreens alone for a moment. The greatest number of species are large growing and tree-like in their ultimate proportions. Examples include firs, hemlocks, pines and spruces, whose average height is more than 50 feet, with a spread at least half that much. The trees grow naturally in large forest groups and are likely to look forlorn alone.

Firs are the least adaptable to town and city conditions. Pines and spruces are tolerant of cold, windy locations and full winter sun. Hemlocks are very adaptable, since they can be sheared, used as hedges, and held to a compact, manageable size. They need a moist but well-drained soil and shelter from hot or cold, drying winds.

Columnar evergreens can be used alone, in groups or in combination with other plants for border, enclosure, or foundation plantings. They introduce height, texture and color wherever they are placed. Use lower-growing ones in pairs to frame entrances, gateways and steps, and singly as an accent.

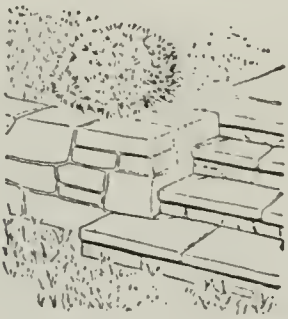
Yew can provide accents in a long border during the months flowers are not blooming and can even be used as a sheared or unsheared hedge. Space the plants 18 to 24 inches apart and trim once or twice a year to encourage compact growth and shapeliness.

The globe and dwarf cone-shaped ever-

greens are an extremely useful group because of their low height. Use them as entrance accents in combination with other low-growing evergreens, or alone at steps, gateways, and paths. Globe-shaped evergreens have a place in low, sheared or unsheared hedges.

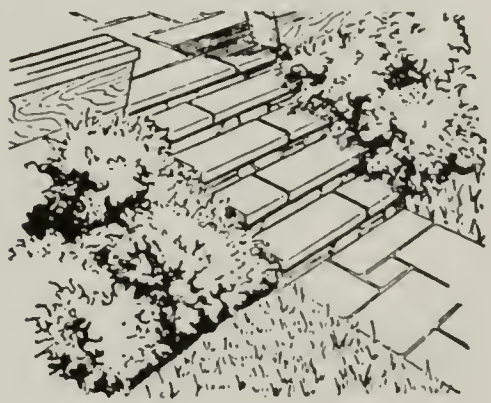
Spreading evergreens are among the most useful of all the conifers. They remain low, may be grouped to form a spreading mass of foliage to screen foundations without blocking windows. They also combine readily with other low evergreens and with taller accents and deciduous materials. Locate them at least 2 or 3 feet from foundation walls.

The procumbent or creeping evergreens are especially adaptable as low ground covers. Some of the junipers have a light gray-green summer color and decidedly purplish tones during the winter.



Single accent at steps is a dwarf Mugho pine. It can be clipped annually to keep its shape and size.

Creeping junipers on a sunny bank.



Smaller trees in pots, such as these, can be shifted to change look and emphasis of a formal patio.

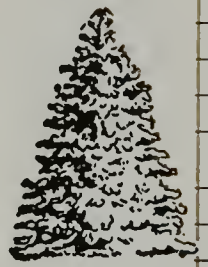
Pyramidal-shaped evergreens develop a broad-based silhouette but reach less than half the size of standard forms. They can readily be sheared and clipped to hold their shape, a technique not possible with pines, firs, and spruces.

The smaller varieties (Siberian arbor vitae, slender Hinoki, false cypress and upright Japanese Yew) may be used as robust accents in foundation plantings away from windows.

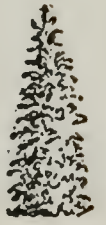
The care of trees. Besides supplying adequate water, you must feed, prune and protect your tree from insects and diseases and injuries such as wind and sun burn, or damage from snow and ice. Feed newly planted trees the first spring after planting and annually thereafter each spring by scattering granular complete plant foods on

ALL ABOUT EVERGREENS

Type (Shape)	Name	Full-Grown Height (ft.)	U. S. Location	Exposure and Soil Preferred	Use	Class Characteristics
	FIR, Douglas	70-80	NE, NC, NW	Sun, partial shade; slightly acid soil, moist	Lawn accent, background, windbreak. Space 5 to 10 feet apart	Soft flat, blunt needles; upright cones, 2 to 5-inch long. Smooth twigs. Popular as Christmas trees
	Nikko	60-70	NE, C			
	Veitch	60-80	NE, C			
	White	100-250	NE, NC, W			
	HEMLOCK, Canada	25-75	NE, S (upper), NC, NW	Sun, partial shade; acid soil, moist	Hedge, background, lawn, windbreak. Space 5 to 10 feet apart	1/2-inch flat, flexible needles; drooping branches; 1/2-inch cones on twig ends. Rough twigs
	PINE, Austrian	50-60	NE, NC, W	Sun; acid soil, moist	Lawn accent, background, windbreak. Space 5 to 10 feet apart	2 to 5 needles in sheathed cluster; needles 1 to 6 1/2 inches. Hanging cones, 1 to 6 inches. Some used as Christmas trees
	Lacebark	to 60	NE			
	Limber	30-40	NW to SW			
	Red	50-70	NE, NC			
	Scotch	to 50	NE, C, W			
	Swiss Stone	30-40	NE, NC, NW			
	White	75-100	NE, NC			
	SPRUCE, Black Hill	50-60	NC, NW	Sun; acid soil, moist	Lawn or garden accent, background, windbreak. Space 5 to 10 feet apart	Pendent cones to 7 inches. Stiff, sharp 4-sided needles 1/4 to 1-inch long. Bushy twigs. Popular as Christmas trees
	Colorado Blue	60-80	N, S, C, E, W			
	Koster	50-60	N, S, C, E, W			
	Norway	75-100	NE, NC, NW			
	Serbian	to 50	E, C, W			
	White	50-60	NE, NC, NW			



1
TREE-LIKE

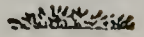


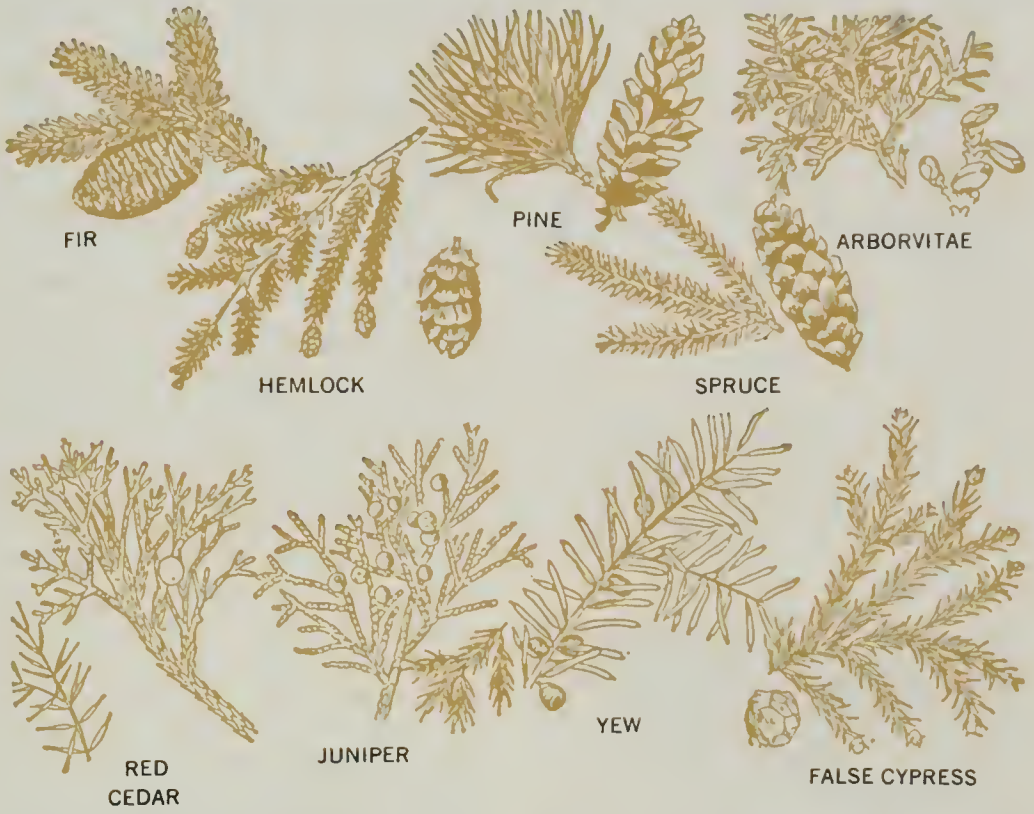
2
COLUMNAR

ARBORVITAE, American	30-35	N, C, E, W	Full sun; ordinary soil, moist	Hedge; lawn, foundation, windbreak, group. Space 6 to 8 feet apart	Flat, spray-like branches; scale-like needles; cones. Aromatic
Douglas	20-25	N, C, E, W			
George Peabody	12-15	N, C, E, W			
Goldspire	10-12	S, C, E, W			
Pyramidal	25-30	NC, NW			
Pyramidal Oriental	25-30	S, C, E, W			
CEDAR (Juniper), Burk red	12-15	NE, SE, C	Sun or partial shade; neutral to alkaline soil	Hedge, lawn, background, windbreak, accent foundation. Space 6 to 8 feet apart	Scale-like needles in flat spray, or sharp needles. Blueberries. Aromatic
Canaert red	20-25	NE, SE, C			
Red	30-50	NE, SE, C			
Silver red	20-25	S, C, E			
JUNIPER, Chinese	20-25	NE, S, C	Full sun; dry, sandy or gravelly soil	Foundation accent, group, border. Space 6 to 8 feet apart	Sott, scale-like foliage or sharp needles or both. Needles 1/4-inch or less. Gray-blue berries
Spiny Greek	6-8	S, E			
YEW, Hatfield	12-15	NE, C, W	Sun or shade; slightly acid soil, moist	Garden accent, foundation, hedge. Space 2 to 4 feet apart	Shiny dark-green needles, flat branches. Red, cup-shaped berries. Slow growing
Hicks	10-12	NE, C, NW			

3
GLOBE OR
DWARF CONE

ARBORVITAE, Berckman	4-5	S, C, E, W	Full sun; moist, rich soil	Foundation, around porches and under windows; hedge, border, group, garden accent. Space 12 to 18 inches apart	Flat, spray-like branches; scale-like needles; cones. Aromatic
Globe	3-4	S, C, E			
Little Gem	2-3	S, C, E			
Parson's	4-5	S, C, E			
Woodward	4-6	N, C, E, W			
FALSE CYPRESS, Dwarf Hinoki	2-3	S, C, E, W	Sun or partial shade; slightly acid soil	Hedge. Space 12 to 18 inches apart	Scale-like foliage. Small globular cones.
PINE, Mugho	4-8	all U. S.	Sun; acid soil, moist	Foundation, garden accent, group. Space 12 to 18 inches apart	2 to 5 needles in sheathed cluster; needles 1 to 6 1/2 inches. Hanging cones, 1 to 6 inches. Some used as Christmas trees

Type (Shape)	Name	Full-Grown Height (ft.)	U. S. Location	Exposure and Soil Preferred	Use	Class Characteristics
4 SPREADING	JUNIPER, Pfitzer	5-6	all U. S.	Sun; dry	Foundation, corners of lawn, border, bank, group. Space 3 to 6 feet apart	Soft, scale-like foliage or sharp needles or both. Needles, 1/4-inch or less. Gray-blue berries
	Savin	5-6	N, S, W			
	YEW, Brown	5-6	C, E, W	Sun or partial shade, moist	Hedge, foundation corners of lawn. Space 3 to 6 feet apart	Shiny dark-green needles, flat branches. Red, cup-shaped berries. Slow growing
	Dwarf Japanese	5-6	NE, NC, W			
	Spreading Japanese	6-8	NE, C, W			
 5 PROCUMBENT OR CREEPING	JUNIPER, Andorra	1-2	NE, NC, NW	Sun; slightly acid soil	Hedge, foundation, ground cover, in groups, slopes, rock garden, border. Space 24 to 36 inches minimum	Soft, scale-like foliage or sharp needles or both. Needles 1/4-inch or less. Gray-blue berries
	Bar Harbor	1/2-1	E			
	Creeping	1-2	NE, C, W			
	Tamarix	1-2	W			
	Waukegan	1-2	NC			
	YEW, Canada	1/2-1	C, E	Shade; acid soil, moist	Hedge, foundation, ground cover, in groups, slopes, rock garden, border. Space 24 to 36 inches minimum	Shiny dark-green needles, flat branches. Red, cup-shaped berries. Slow growing
6 PYRAMIDAL	ARBORVITAE, Siberian	12-15	N, C, E, W	Sun; slightly acid soil	Foundation, background, windbreak, hedge. Space 2 to 4 feet apart	Flat, spray-like branches; scale-like needles; cones. Aromatic
	FALSE CYPRESS Hinoki	30-35	S, C, E, W	Sun or partial shade; slightly acid soil, moist	Foundation, background or frame, windbreak, hedge. Space 2 to 4 feet apart	Scale-like foliage. Small globular cones
	Moss	25-30	S, C, E, W			
	Plume	35-40	S, C, E, W			
	Slender Hinoki	12-15	S, C, E, W			
	Thread	20-25	S, C, E, W			
	YEW, Upright Japanese	20-25	NE, C, W	Sun or semi-shade; slightly acid soil, moist	Foundation, hedge, accent, windbreak. Space 2 to 4 feet apart	Shiny dark-green needles, flat branches. Red, cup-shaped berries. Slow growing



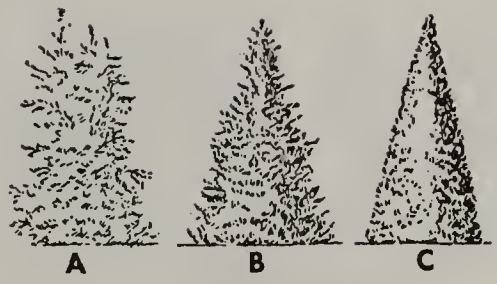
the water ring and soaking it in, or by applying soluble liquid foods alone.

Pruning evergreens consists primarily of helping each type develop its own shape by encouraging compact growth. Do not prune large growers to keep them low, nor train low, spreading types to grow upright. Prune evergreens each spring just as new growth is starting, and again lightly prune trees that grow fast and lose their shape.

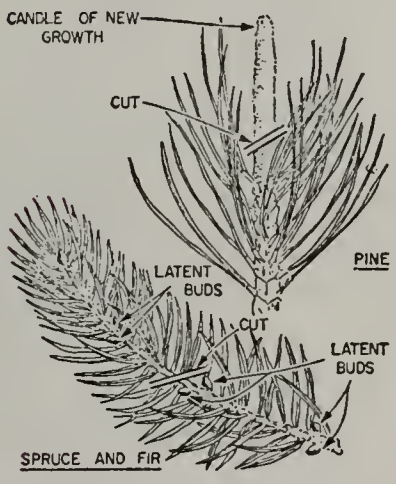
Evergreens with many thick branches, such as the yew, arbor vitae, juniper, false cypress and hemlock, are the easiest to control. Trim individual branches and shear branchlets. The long-handled, long-bladed hedge shears and electric hedge shears are the quickest and easiest but they tend to give evergreens a harsh, artificial appearance unless the trimming is done with care. Pruning individual branches with the small hand clippers results in a more natural appearance. Spreading evergreens should always be pruned, never sheared.

The firs, spruces and pines are more difficult to prune, yet need it from time to time to control growth that could spoil the shape. Prune large-growing trees in the spring, before or while they are showing new growth. Removing part of the new growth (candles) of pine trees will cause side branching to increase in thickness, and will keep Mugho pines low and compact. A part of the soft, new growth may also be cut away on firs and spruces, or cut just beyond latent side buds, which appear along terminal shoots or branches. Always make heavy cuts back to a living side branch to avoid die-back of stubs.

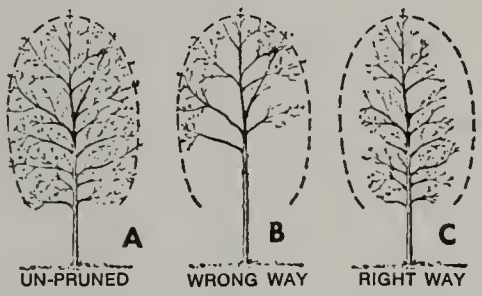
Transplanting trees. To prevent disappointment and loss, take the time to discover the right ways to transplant trees. There are few rules, but if you follow them



The stages in pruning an evergreen.



How to prune large-growing trees.



When pruning, cut back lateral branches (C) rather than cutting out complete branches (B).

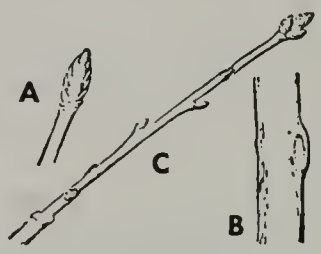
you can be certain the trees you transplant will survive.

Don't move trees during a period of rapid growth: for deciduous varieties that is the time immediately after new leaves appear and for evergreens the time is in the spring, when moisture and temperature conditions are best. Move trees when they are dormant, as in the fall. If you live in an area with harsh winters, consider transplanting early enough in the fall for the tree to be safely situated, or in the spring before the sap begins to flow. Evergreens are best moved in the early fall or late spring, but don't try to move one into cold or frozen soil.

Types to transplant. Young, vigorous trees are easier to move than well-established ones, and nursery grown trees are usually best because they have already been moved from seed bed to open rows several times. The tops of nursery grown trees will have been pruned to match the root structure.

If you plan to transplant established trees, select those growing in open areas rather than in a jungle of shrubs and other trees. You'll be able to dig out roots with less damage. Look for trees in a thick, heavy soil rather than loose, sandy soil. A loose soil develops stronger roots and thus a tree is harder to dig up.

You can check the vigor of a tree by noting the size of buds, length of annual twig growth and the color of cracks in the bark. Buds should be fat and well filled. Cuts, cracks or abrasions heal by rolling over the damaged area with a scar tissue that forms a callus, and the tips of twigs should grow from a scar that forms when the trees goes into a dormant period. Four to eight inches usually indicates a normal growth. Finally, look at the bark fissures



Buds, length of twig growth and color are all indicators of an evergreen's health.

MINIMUM EARTH BALL SIZES

Columnar Coniferous Evergreens		Broad-Growing Coniferous Evergreens		Small Deciduous Trees	
Height of Tree	Diameter of Earth Ball	Height of Tree	Diameter of Earth Ball	Height of Tree	Diameter of Earth Ball
18″-24″	11″	18″-24″	11″	18″-24″	11″
2′- 3′	12″	2′- 3′	13″	2′- 3′	12″
3′- 4′	14″			3′- 4′	14″
4′- 5′	16″	3′- 4′	15″	4′- 5′	16″
5′- 6′	17″	4′- 5′	17″	5′- 6′	18″
6′- 7′	19″	5′- 6′	19″	6′- 7′	20″
7′- 8′	21″	6′- 7′	21″	7′- 8′	22″
8′- 9′	22″	7′- 8′	24″	8′- 9′	24″
9′-10′	24″	8′- 9′	26″	9′-10′	26″
10′-12′	27″	9′-10′	28″	10′-12′	29″
12′-14′	30″	10′-12′	31″	12′-14′	32″
14′-16′	33″	12′-14′	35″	14′-16′	36″

Uprooting and moving a tree is a shock which even a healthy tree may not survive. Transplanting from one type of soil to another makes the problem even more difficult. Match the soil condition as closely as possible. Adding lime will reduce soil acidity. Sulfur or aluminum sulfate will increase acidity. Evergreens should be moved with a root ball of earth which is appropriate for the size of the tree. Check the tables here for details.

LIME REQUIREMENTS FOR SOIL TYPES OF DIFFERENT REACTION

Present pH of Soil	Pounds of ground limestone needed per 1000 sq. ft. to raise					
	Sandy-loam soils		Silt-loam soils		Silty clay soils	
	To pH 6.0	To pH 6.5	To pH 6.0	To pH 6.5	To pH 6.0	To pH 6.5
6.0		23		41		58
5.5	23	46	41	83	55	115
5.0	46	69	83	124	115	173
4.5	55	78	97	138	138	196

SULFUR OR ALUMINUM SULFATE NEEDED TO INCREASE ACIDITY OF SILT-LOAM SOIL (PER 100 SQ. FT.)

From pH	To pH	Sulfur (Lbs.)	Aluminum Sulfate (Lbs.)
8.0	7.0	2	4.5
8.0	6.5	3	7
8.0	6.0	4	10
8.0	5.5	5.5	13.5
8.0	5.0	7	17.5
7.5	7.0	1.75	3.5
7.5	6.5	2	5
7.5	6.0	3.5	7.5
7.5	5.5	5	11.5
7 5	5.0	6.5	15.5
7.0	6.5	1.5	2.5
7 0	6.0	2	5.5
7.0	5.5	3.5	9
7.0	5.0	5	13
6.5	6.0	1.5	3
6.5	5.5	2 5	6.5
6.5	5.0	4	10.5
6.0	5.5	1.5	3.5
6.0	5.0	3	7.5
5.5	5.0	1.5	4

and examine the color. Just under the bark's outer surface and in these fissures, the bark should be much lighter than the outer surface.

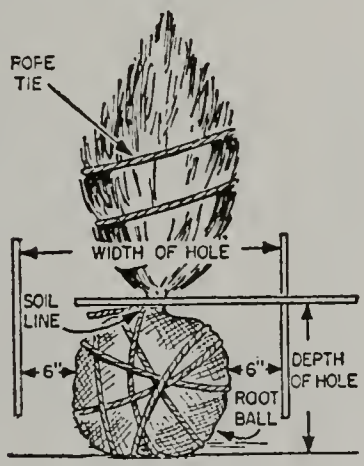
Soil preparation. Since uprooting and moving a tree to a new location is a shock which even healthy trees may fail to survive, the complication of a different soil makes the problem even more difficult. Match the soil conditions as closely as possible. In clay soils, add a layer of gravel and sand in the bottom of the hole for drainage. In sandy soils, add humus or compost for better moisture retention. To find out the relative acidity of the best soil, check the pH of the area where the tree is now growing. Holly and laurel prefer highly acid soils, but most trees thrive in neutral or slightly alkaline soils.

If the soil where the tree is to be planted should vary from the desired pH, you can reduce the acidity by adding lime. If the soil is too alkaline, it may be treated with sulfur or aluminum sulfate.

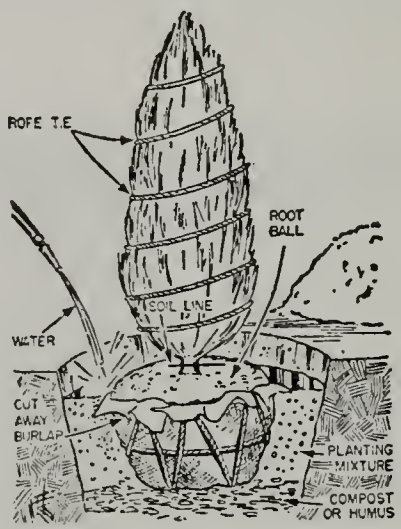
Transplanting. Tie bushy, low-branched trees to prevent damage. Deciduous trees (those which lose their leaves every winter) can often be moved bare-rooted, that is, without a ball of earth enclosing the roots. Carefully remove earth around roots, retaining as many of the small fibrous roots as possible. Keep these roots moist until planting either by heeling them in a shallow trench and sprinkling or by covering with damp burlap or sphagnum moss.

Evergreens should be moved with a good sized root ball of earth, and only when there is plenty of moisture in the soil. If necessary, water thoroughly at least two days before moving.

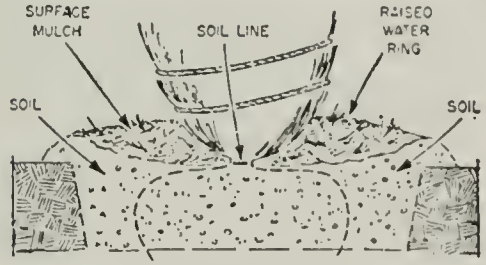
Small root balls, those up to about 15-16 inches in diameter, can usually be wrapped and removed with a shovel. Dig straight around the sides with the back of the spade toward the trunk of the tree, if possible. Dig away from this ball enough to get good leverage, then break the remaining roots by prying. Lift the ball out onto a square of burlap and tie corners diagonally if tree is to be moved only a short distance, but if the tree is to remain out of the earth for more than a few hours, tie the burlap tightly, then wrap it with heavy cord. Larger root balls, over 18 inches in diameter, are too heavy for manhandling. Daub major



▲ *Measure root ball before replanting.*

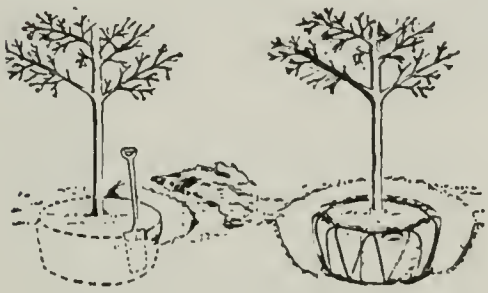


➤ *The correct way to prepare the site and to replant a tree.*

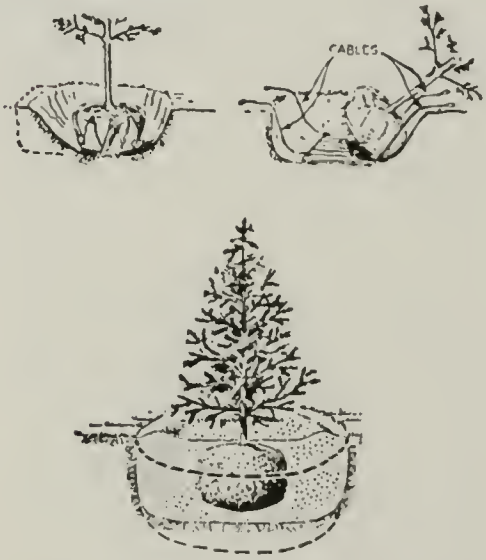


▲ *How to mulch and shape the water ring of a newly transplanted tree.*

▲ *How to transplant a tree being moved only a short distance.*



▲ *This shows how to prepare a tree for transplanting if its root ball is more than 18 inches in diameter.*



▲ *Larger trees must be rigged with cables, hoisted and trucked. Dig the replanting hole in advance so that the tree will be out of the ground for the shortest possible time. Dig the hole twice as big as the root ball.*

▲ *If the soil is poor, make the transplant hole 6 to 12 inches bigger than usual to accommodate peat and soil.*

▲ *Before backfilling, remove burlap from root ball. When backfilling, be sure to leave a ridge around the tree to retain water.*

root ends with an asphalt compound. Undercut sides about 3-4 inches by shaving off earth with spade. Wrap and tie burlap sacks around sides and over top, using ¼-inch diameter rope. Undermine all sides and tip the tree in one direction. Cut any roots extending below the ball. Work a wooden platform below and tie cables at each corner. Hook cables to hoist and lift the entire package onto the truck for hauling.

To reduce the time trees are kept out of the ground, dig transplanting holes at the

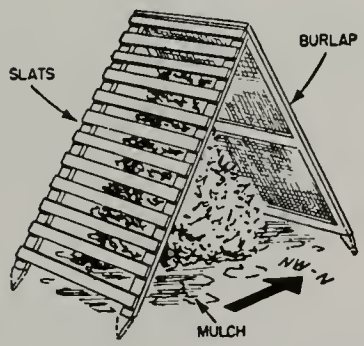
new site in advance. The new hole should be at least twice as big as the root ball and deep enough to allow 5-10 inches base of good soil. In cold weather, keep the hole from freezing by covering it with straw or manure. As you prepare the hole, separate the black top soil in one heap and the bottom soil in another. If the soil is not good for growth, increase the size of the hole to permit filling with a better mixture. For deciduous trees mix one part of peat moss (by volume) with about three parts of soil. For evergreens, try one part peat with two parts soil. Place tree at the same depth or 1 inch below its original depth. Spread out bare roots in a natural position and cut off any that are bruised. Cover with fine top-soil and tamp gently to remove air pockets. Then water and let the soil settle. When water is gone, fill remaining space with a soil-peat mixture and leave a ridge to form a saucer that will retain water around the base of the tree.

When planting balled and burlapped trees, remove the burlap before backfilling and loosen any hardened outer soil with a spading fork so that it will not retard root growth. In the fall, mulching around trees planted with 2 to 5 inches of straw, manure or leaves to protect roots helps. In the spring, cultivate the remaining mulch into the topsoil.

Prune top growth after planting because the reduced root structure cannot supply sufficient moisture and nutrients to leaves. As much as one-half of the foliage should be cut away, unless it has been previously cut back at the nursery. Do not cut the top leader of a single-stemmed deciduous tree unless you want a low-headed or exceptionally spindly tree. Instead, cut back the lateral branches. Do not prune small twigs and buds along the main trunk leaving a few buds at branch tips—the system leaves buds too far from the tree's sap system for good growth and opens the main stem to sun scalding. Unwanted trunk growth can be trimmed when branches are fully established. Evergreens require less pruning because they are usually transplanted with a ball of undisturbed earth.

Hold the tree in position with extra support until the roots become well established. One or two stakes driven alongside and tied to the trunk with a cord through a length of rubber hose makes a good support. Another is three stakes with wooden cleats nailed between them and a third uses three guywires from ground stakes to a protected loop in a low crotch. In windy regions, add a screen to keep cold winter winds from drying trunk and leaves before the roots replace the lost moisture.

See also: BONSAI; FERTILIZERS; GARDENING; GARDEN PLANNING; GRAFTING; LANDSCAPING; LAWNS.



▲ *Simple screen provides winter protection from sun and wind.*

▼ *Use a screen to protect a newly transplanted tree from the wind. Wrapping can protect tender bark.*

How to Troll for Fish

The key to catching game fish is knowing the habits of the smaller fish on which they feed

THERE'S FAR MORE to trolling than blindly dragging lures across the water, hoping for a hit. Only greenhorn skippers leave the dock without making plans based on "fish savvy" plus the known habits of the species they're pursuing. Haphazardly trolling through unfamiliar water is about as productive as shooting a random shot into the woods and expecting to down a deer.

Whether you're skipping strip baits off a set of outriggers for marlin from an offshore cruiser or working a spoon deep on Monel wire for lake trout from a rowboat, you should employ the same trolling principles. The techniques that take tuna off Nova Scotia will land lakers in Ontario. The systems used on striped bass near Cuttyhunk are excellent in San Francisco Bay.

The basics start with the movements of bait. Sea trout in the Everglades are often found where a tidal rip makes up off a mangrove point. In the Florida Keys and off the Bahamas, barracuda frequent deep channels that cut through the coral reefs.

Along the Outer Banks of North Carolina, the best channel bass fishing occurs near the inlets and around sunken wrecks. Stripers in Rhode Island and Massachusetts lurk near rock breakers and in such hotspots as the Cape Cod Canal. The common denominator is feed. Fish live to eat.

Baitfish are ordinarily difficult to spot. The only natural weapons these small species have are protective coloration and camouflage surroundings. Thus, in most waters, both the fishermen and the gamefish have difficulty finding schools of bait.

Why? Swimming in a natural position, the bait's backs are difficult to see from above against the dark bottom. Their white bellies silhouetted against a light sky are almost invisible from below. Gulls, anglers and predators are likely to overlook bait in normal seas.

It's different in turbulent water. Let an unexpected current tilt one small fish so the natural protective coloration is exposed and a feeding flurry starts. It's most likely to occur in a current rip, an eddy behind a rock ledge, near a reef, inlet, breakwater or wreck. Offshore, it can happen on a dropoff or the edge where a current such as the Gulf Stream meets shallower waters.

In a lake, look for the confluence where a creek or stream empties into the main body of water. Try to locate a spring hole from underground. Look for deep pockets, particularly where they're found adjoining a peninsula or finger bar.

On a river, try the eddy waters down-

stream and behind a point or bend. Look for overhanging limbs and submerged stumps. Watch grass beds near deeper water.

Study the water before you start trolling. Try to understand something about the bottom configurations and the surrounding depths. In tidal areas, learn where the rips form and when the change takes place.

The United States Coast and Geodetic Survey office in Washington, D. C., will supply you with navigational charts that make saltwater prospecting a cinch. For an investment of about one dollar, you can see the islands, spot the finger bars extending off-shore and range underwater rock ledges before leaving your living room. When you cast loose the dock lines, you'll be trolling with your head as well as your instincts.

Securing equivalent charts in freshwater can be a mite more difficult. Quadrant maps are available in many areas through state conservation offices and tourist travel bureaus. The Army Engineers might be helpful where their projects are underway. In Canada, you can use the National Topographic Series published by the Department of Mines and Technical Surveys with good results.

The depth of your trolling lines is the next problem. There aren't any hard and fast answers. Largemouth bass might be breaking on the surface in the cool daylight air, feeding on minnows in the shallows. After the sun has warmed things up a bit scarcely an hour later, the same fish will seek refuge in deep, quiet pools.

Bluefish and striped bass feed voraciously on top at dusk and dawning—and occasionally with the running of the tide. Yet Montauk charter captains record their greatest success with these species plunging lures deep with Monel wire lines.

What should you do? Your best bet is to rig at least two sets of trolling tackle, one for top water trolling and the other for dredging bottom. For the first, any good grade of line will suffice. For the second, you have the choice of monofilament used with a weight or the variety of wire and lead-core products on the market.

Some prefer monofilament on top since it gives you a minimum water resistance while offering flexibility for changeovers; single-strand Monel for deep trolling since it lasts longer and is easier to handle than the multi-strand varieties.

Let's combine theories about bait and depth. A trolling feather simulates a squirming silverside only when it's gyrating where the bait would normally be. A silver spoon flashing close to the bottom on a hot summer day will entice lake trout to bite because they're normally feeding at these depths. A strip bait may cause a marlin to raise from the bottom but most billfish are spotted before they smash a bait.

When you see obvious signs of surface activity, try trolling high. Mewing, circling gulls working a school of feeding stripers in a tidal rip mean prime candidates for topwater lures. Any species of gamefish walloping insects during a hatch can be caught on top.

Conversely, when there's no indication of activity visible to the eye, try dropping your lures where you can't see. Go deep. Search for game at varying depths from top to bottom. Remember that the small stuff changes height with tides and temperature; the big lunkers go with their feed.

Suppose you're trolling a lead-head jig for bluefish throughout the day. It would probably work well on standard nylon or Dacron line on top at dawning. An hour after the sun rises, experiment with slower trolling speeds and letting out additional line—both maneuvers designed to make the lure work deeper. Instead of following a straight course, yaw the boat now and then to give the lines momentary slack so they'll drop further.

Later in the morning, the identical school

◀ *Trolling an inlet for striped bass and bluefish.*

▼ *Gaffed pacific yellowtail was caught with a trolled feather lure.*

▲ *Fighting chair on an offshore boat. The kidney harness is linked to the reel. The line is rigged for bluefin tuna.*

of blues might be jigged off the bottom on wire. Mark the Monel with colored paint at 100-foot intervals so you can tell how much wire is out. Then troll one rod at approximately 200 feet; another at 300, etc. After a while, when fish start hitting, adjust them all to the same distance.

Know your fish. A neophyte spotting flurrying bluefish cutting up a school of bait might race his boat to the spot and then start trolling. Cutting his engine speed at the edge and running through the center, he might pick up a few before sounding the fish. At this point, the same duffer probably would make several circles before heading away in disgust.

The oldtimer knows that bluefish are left-handed feeders by preference, approaching bait with their victims to port. With the fish slashing through a school of sand eels while headed offshore, the boat should approach on the outside rim circling counterclockwise. It's wisest to be outside the limits of fish vision where possible. Your engine speed should remain constant to eliminate abrupt changes in vibration underwater.

If the fish are skitterish and sound despite all your efforts, drop a marker buoy to fix the spot. Gradually widen your search pattern by increasing the radius of your circles. Wheel the boat port and starboard so forward motion is lost and the lures change depths. Have one or two angles let out long lines while the others troll closer to your transom.

Where currents are swift and the use of marker buoys is inconvenient, get a range on conspicuous landmarks. Draw a line of sight over a beach cottage in one direction and a can buoy in the other. See if you can find a telegraph pole, tall tree or radio tower that will help you fix the spot.

With such a range, you'll be able to re-

➤ *Hauling in a striped bass caught with a trolled eel.*

Barracuda hooked. Spinning tackle is eased alongside.

Fisherman will use whole mackerel rigged with two hooks to lure giant bluefin tuna off Prince Edward Island.

turn. Remember that there's likely a combination of aquatic conditions under the water that makes this location slightly better than a chunk of water a mile away.

It's the same in fresh water or salt. There's a pattern to trolling no matter what the game. Fundamentally, trolling speeds should be slow. With the major exception of fish in the tuna family, your game will prefer a sluggish pace. Throttle down when you're after snook, drum, bull's eye mackerel, lake trout or muskies.

Choosing a few typical examples, a proper speed would be about three knots offshore after sailfish and dolphin. Cut the motor to a snail's pace after muskies. Make bare headway for best results on striped bass, fluke or sea trout.

Tuna like more of a breakneck speed. The school fish go in large schools, often following a wounded member on a hook right up to the transom. Experienced charter skippers often keep one fish in the water, using it as a decoy to keep the remainder in the vicinity of the boat.

Keep a sharp lookout aloft. Some of the best anglers never take their eyes off the water. They're always looking for a swirl or the flash of silver baitfish skittering on the surface. They've learned to spot the fragile limb-like fin of a white marlin sunning itself. At half a mile distance, a breaching swordfish is as obvious to them as an erupting volcano.

But there are other telltale signs that are as important to a fishing helmsman as aquatic game. Keep a weather eye out for changes in water coloration that indicate differences in depth. Montauk chartermen make a habit of attempting to head out of the blue ocean into water with a greenish hue since a few stray Gulf Stream currents touch within their trolling range.

Fish often travel in the warm fingers of big ocean and lake currents. Sometimes, particularly with the aid of Polaroid sun

glasses, you can detect these natural phenomena by color.

In this age of electronic accessories, you can often do well with a fathometer supporting your eyesight. In places like the striper grounds under the Chesapeake Bay Bridge, sharpshooter skippers pinpoint schools of bass with their depth sounders before putting the lines over the stern.

In warmer seas, baits like the sargassumfish lie in the shade of floating kelp beds and pieces of driftwood. Since they're yellow in color and a favorite food of roving dolphin, it's simple logic to drag a yellow feather near any piece of flotsam with a reasonable possibility of getting a hit.

Carry a good selection of lures and trolling baits. Every angler has known the heartbreak of trolling in the middle of feeding fish without catching a thing. Maybe their appetities are attuned to a single wavelength —maybe they're playing rather than eating. Confronted with such a situation, your problem is the same as enticing a finicky youngster to eat.

The answer could be a different color feather or spoon. It could be a different action in an artificial lure—such as changing from a surface popping plug to one of the underwater swimmer or darter varieties. While trolling lake trout off Camp Chimo in Ontario an Indian guide produced results by adding a piece of chunked fish to the trolled spoons.

In saltwater, never go offshore with one bait or even a single variety. Rig a squid—then support your choice with an eel and a whole mackeral. A broadbill won't appear behind the outriggers every day but on that memorable occasion when it happens, the swordfish may be persnickity. A variety of baits as offerings might change your fish story into a victory chant.

Trolling will damage your baits no matter how well they've been sewn and tied. Remember that many of the big deep water gamefish hunt by smell and taste—and that uneventful hours of trolling will wash away scent completely. It may sound overly fussy, but change an outrigger bait every hour or two—just on the assumption that fresh food is far more attractive than leftovers.

The action of a trolled lure. Never drop a plug over the side without dragging it a couple of feet to observe the action. By bending the eye of your plug, you can adjust it to depth and the particular gyration that might produce results.

There is nothing alive offshore that swims with a spinning motion. Since your outrigger baits should resemble live prototypes, you desire a natural action. Squid baits should be trolled with a bounce; the wings outstretched. Strip baits must undulate vertically, eels horizontally. A whole mackerel shouldn't pick up grass because someone aboard forgot to remove the backbone before threading it to the hook.

If you don't know the insider's tricks and gimmicks, try to persuade a local troller to go out with you for at least one day. Instead of telling him about all the fish you've caught in the past, ask intelligent questions and attempt to add to your "fish savvy" from the answers. Listen first! Later, you can make up your mind whether the advice is worth heeding.

More fish are caught by throwing away the rule book than by sticking to prescribed systems. The extraordinarily effective West Coast kite rig was discovered by a dabbler who reasored that he was missing fish that were educated to a boat's wake. Some recommend that a bait be trolled away and across a big fish, but others say that marlin can't resist hors d'oeuvre brought directly into its mouth.

What's the answer? In fishing, no rules are inflexible. When you've tried all the gimmicks dredged from prior experience without success, put on your thinking cap and do some experimenting on your own.

See also: BASS FISHING; FISHING; FISH PREPARATION; KNOTS; LURES; TROUT.

Fish with Outriggers

You can buy them or make them yourself to keep lures out of your boat's slipstream

WHETHER IN COASTAL or inland waters, cruisers with outriggers skip lures far out to each side of the boat—away from the propeller slipstream. Sail-fish, marlin, dolphin, bonita and any number of smaller fish that strike a moving lure may be hooked with the line strung from the outrigger.

The actual fishing line is not attached to the outrigger, but comes from a rod and reel which the fisherman holds from the cockpit. A looped line strung between two glass eyes has a spring-type clothespin tied on which holds the fishing line. The baited line is clamped in the pin and snaked to the top end of the outrigger. When the fish strikes, it pulls the line from the clothespin down to the rod, ready for playing from the boat's cockpit.

Rugged outriggers can be purchased, like the ones on charter boats sailing from the Florida coast, but you can make your own stationary or movable one. A stern flag pole socket 1½ inches inside diameter will hold a bamboo pole, or you can braze a length of bronze tubing to a deck plate and screw the assembly to the side deck.

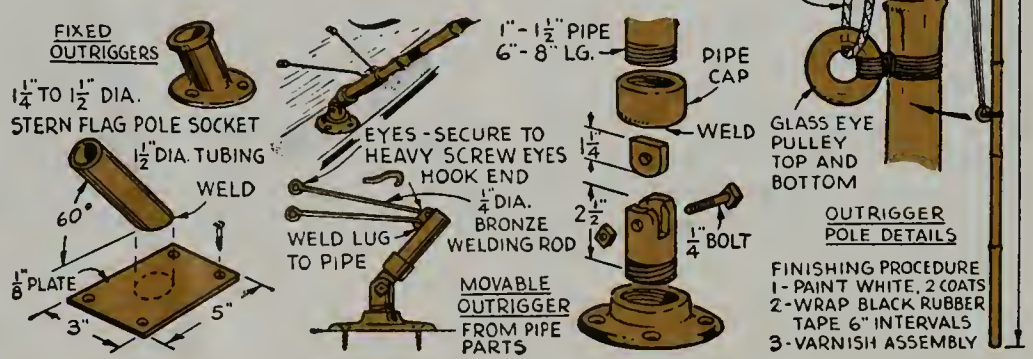
Better than the fixed type, that must either carry the pole slanted directly back or a removable pole, is the hinged socket that allows the outrigger to range far outboard, yet can be drawn in close when at the dock. Construct a hinged socket from pipe fittings with the flange screwed to the

side deck and rods that hook to screw eyes in the extended position.

The outrigger itself is a large diameter (1½ to 1¾-inch.) bamboo pole 16 to 20 feet long fitted with one fair lead near the top and two glass-eye pulleys at top and bottom. The looped ⅛-inch venetian blind line should be fairly tight. Lash a strong springed clothespin to line.

See also: BASS FISHING; FISHING; KNOTS; LURES.

Fishermen angle for bait while they wait for game fish to strike rigs trolled from outriggers.



Professional Secrets for Taking Trout

Forget about witchcraft and wizardry. What you need to catch trout are patience, persistence and ingenuity

THE DETERMINED, STUDIOUS approach is the one that will take the most and largest trout. To be successful consistently, a truly expert trout fisherman must be ingenious. He must also be stubborn, and patient. Trout are highly specialized creatures, fitted intricately to the environment. Sometimes they seem so easy to catch it is ridiculous. At other times they seem impossible. But when they are feeding they are never impossible—if you can find what's needed.

At times that is so simple one fails to discover it because of the simplicity. For example, one of the great secrets, particularly for early season or opening day trout angelers, is to locate first the type of water the trout are in.

The average trout fisherman will get into the deeper water and fish with bait or wet-fly down into the dark recesses. He may immediately hit the jackpot. Then again, he may fish half a day there with an empty creel.

Sometimes, for reasons best known to themselves, trout from the deep glides immediately below a riffle will all crowd up into the swift, shallow water to grub aquatic nymphs from the rocks. In the rough water you do not see any evidence that they are there.

Like a horse in a pasture, a trout may graze an "open meadow" this morning, a "shady glade" this afternoon. Also, the fish may not be feeding at all. Trout, just like any other living creatures, have feeding periods. John Alden Knight with his Solunar Tables tries to figure them out exactly and it is possible he may have correctly done so. Many anglers successfully use his tables. Regardless of when and why, the accomplished trout angler will come to realize that in many instances trout are either feeding or not feeding and when they are not there is little you can do to force them.

This does not mean you should leave the stream. The secret here is to be prepared. Trout lie quiet on the bottom of a clear

truck campers: see campers
tube, tv: see color television
tuckpointing: see masonry
tulips: see flowering bulbs
tuners: see high fidelity systems

pool for hours at a time. Drift a fly or bait past, and they simply ignore it or move over. Then, suddenly, one or two begin to move around. One rises and takes some floating food. Within a few seconds at times the whole stream will come alive. Such a spree may last only a few minutes. Being there, and ready, is the secret by which many an old hand loads his creel. A less experienced angler may think the veteran has some hush-hush method. Actually what has brought him success was his patience. He outwaited the fish!

Each trout *species* has its own whims and habits and idiosyncrasies. The brook trout has been long pampered as a kind of sweet little fellow. The truth is, the brook is possibly the most vicious of all trouts. He is a rambunctious feeder, slamming lures with a vengeance. That is one reason for the brook trout's decline in many places; he is the easiest of all trouts to catch.

For example, find a beaver pond back in the Maine or Michigan woods and ten-to-one brook trout will reside there. If you fish these wild trout with normal care, you can catch every one—but please don't. In a swamp stream that meanders through alders, the brook trout will always lie in the same kinds of places; back under the low-limbed bushes, under a submerged log, beneath a cut-bank, in a deep hole.

The mistake most anglers make is to wade in and cast the fly right onto or into the deep hole. If the trout lying there is large, therefore old, he is wise by age alone. Chances are the cast will scare him. The way to catch him is to place the fly at the edge of the hole, or at the edge of the cut-bank. Thus, no line splash alarms him, no leader coils show on a poor cast. Most of his food he sees at the edge anyway. He slams out and whammo, you've got him.

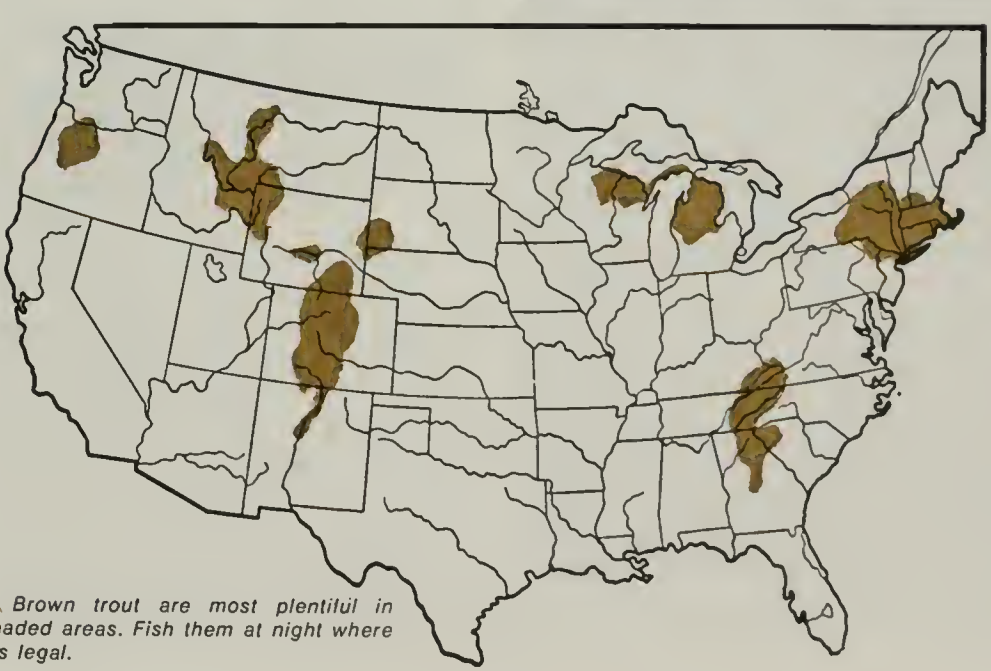
In such a stream, in fact in many waters where brook trout are at their best—slower, deep, cold streams—problems meet the fisherman that sometimes seem insoluble, and sometimes he does not recognize what

Large brook trout from Ontario bush. Be sure you're on hand, ready, when feeding starts.

Even the wary brown trout can be taken by a patient angler.

his problems are. Such streams are inclined to roil easily. An angler wading downstream muddies the water ahead of him and may be putting his trout "down" as he goes. But, he says, he is a bait fisherman. He likes to use worms or some other bait and how else can he do it? Ha! He has but to turn around and fish his bait in a totally unorthodox manner. He should use a very tiny weight, if any at all, make short casts upstream into the deep holes, raise the rod tip high to keep line or leader without a lot of slack. He can then feel the bite. This is one of the most murderous methods of bait fishing extant.

Brook trout in some waters also have an odd habit of selecting tiny pockets in which to lie—pockets ordinarily overlooked by the angler. Take, for example, one stretch of a certain Great Lakes stream that no one bothers to fish. The bottom is very dark. The stream is fairly wide, and so shallow it seems ridiculous to even imagine a trout



Brown trout are most plentiful in shaded areas. Fish them at night where it's legal.

These brook trout came from a high lake in Wyoming. At times, brook trout select tiny pockets to lie in—pockets anglers overlook.

anywhere. But this, too, is a typical swamp stream, a typical brook trout water. The way to fish it is to use a very small, light boat that draws no more than two inches of water. Float, so not to roil the water, and cast a small streamer to pockets by an old stump or root. You may take scores of good brook trout from this apparently fishless place.

The rainbow is quite a different fish. It may be said to be the most "standard" of our trouts, one of the most delightful to catch because it so commonly turns out to be a high jumper. Rainbows live in a great variety of waters today, from the sections of southern rivers below high dams in Tennessee, North Carolina, Arkansas and Missouri, to western mountain peaks with their heads in the clouds. Because this fish has been hatchery bred by billions, and distributed over a vast territory, it is not al-

Brook trout, easiest of all trouts to catch, are best found in areas indicated here.

ways the same in habits. It is geographically less predictable.

This is a little-understood facet of rainbow fishing. It is not true, for example, as some writers have said, that the rainbow is always a perfect dry fly fish. There are many waters where it almost never feeds on surface. There are some waters, indeed, where it is all but impossible to catch rainbows on flies of any kind. Mainly this is because the flies, such as streamers, cannot be got down deep enough without much added weight, and so it is far simpler to use spinning gear and hard lures. A good example is the White River below Bull Shoals Dam, in Arkansas.

This stream has some tremendous rainbows in residence. They seldom feed as rainbows do in certain other places. They exist on minnows and other large forage. Native guides and visitors have learned to catch them by using such lures as a fair-size silver flatfish, a husky-sized super-duper, or a big nightcrawler fished right on bottom.

Go now to a place like Michigan's famed Sturgeon River. It is true that many rainbow of modest size has been taken from the Sturgeon on dry flies and various other flies. It is also true that 99% of the large rainbows for which that river became famous were and are taken on deep-swirled bait such as a snake-sized nightcrawler, or on a spoon or small plug fished into the deepest holes.

In other words, trout of all kinds but particularly rainbows, are so to speak victims of their environment. They find themselves in a specific place, and they must learn to live the best they can with those specific conditions of food, safety, and hiding. The Gallatin River north of West Yellowstone, Montana, is a beautiful but roaring torrent filled with big slick boulders and a nightmare to wade. It can also be a nightmare for a dry-fly man. And, for the first-timer, an enigma. Where in Heaven's name could a trout lie, here?

Don't give small waters like these the go-by. Sometimes even rather large trout lie in them—so be prepared.

Nice one from a western lake. Patience and a studious approach are among the most important "secrets" of successful trouting.

Simple. In this wild turbulence, there is below every boulder a pocket large or small that is completely calm. These are perfect havens for the rainbows that live here. Food swirls around from above the boulder. Safety and comfort are here. This is wet-fly water, because wet flies are easier to fish here, and because much of the time the fish live on submerged aquatic food. However, the bait fisherman can simply slay rainbows here, or in any comparable water, if he'll use a single split shot, hold his rod high to avoid snagging, and let his bait roll and tumble in behind the boulders. The trout here are accustomed to this sort of thing.

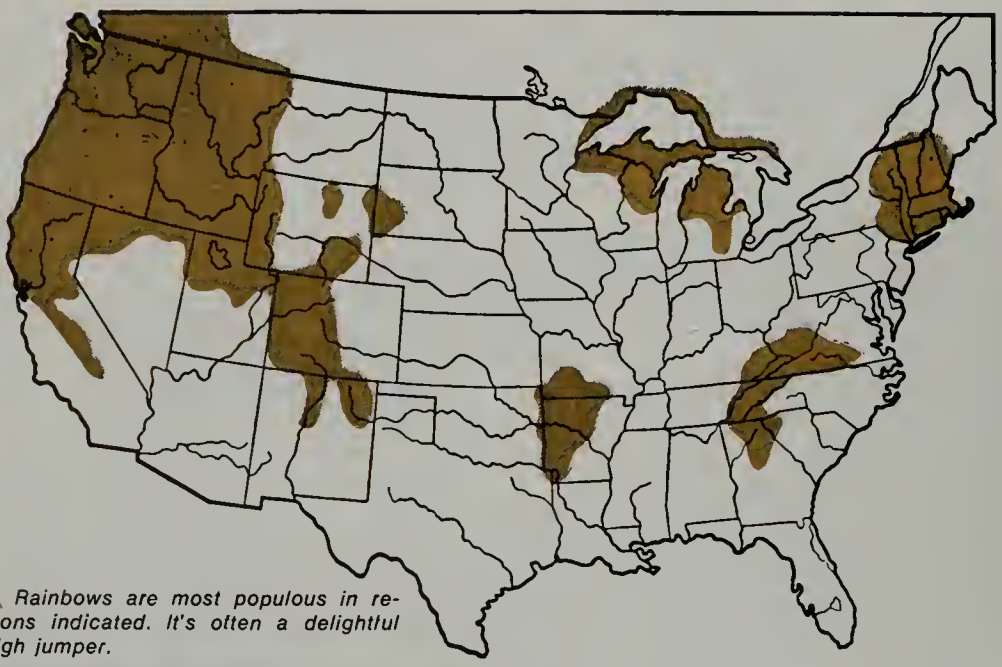
Clinch River, Tennessee, swarmed with white bass. Farther upstream were rainbows.

On Firehole River in Yellowstone, browns often feed on such shallow riffles as these.

Conversely, there are hundreds of waters where rainbows are brought up feeding on insects, and sometimes mostly—as an exaggerated example—on surface insects. If the angler properly evaluates such a water, he will soon discover that the dry fly is what will load his skillet. In other words, because the rainbow has been so much handled by fish culturists, so widely stocked in such a variety of environments, it is today a fish of many habits, but always of habits related to the particular habitat. The angler who cases his fishing water first and who makes relevant deductions, is the one who will then automatically use the method best suited to those particular trout.

Brown trout are something else again. Begin with highest respect for their wariness, and you will have at least part of your

Big bushy fly was used for this big brown. Brown trout are lurkers with voracious appetites, but they can be awesomely selective.



▲ *Rainbows are most populous in regions indicated. It's often a delightful high jumper.*

problem solved. Browns are lurkers, with voracious appetites. But they can be so awesomely selective that you must pick and choose and never hesitate to change and change flies until you have suited the fish.

However, because they are such lurkers, many anglers fail to approach them properly. Let us say you are fishing a meadow stretch of a large stream. The stream is swift. There seem to be no special hiding places. But look again. The banks of such a stream, even though low, are usually undercut—a pocket here, a pocket there. Of course, if fish are actively feeding on a riffle or out in the middle obviously you should fish them. But if you get no activity, get as far out as you can and fish back toward the bank.

Many such banks won't look like much —to you. You aren't a trout. Get your lure down deep. You will double your catch of brown many times, if you use a sinking fly line. These are available almost anywhere.

◀ *Seven rainbows from catch of one morning.*

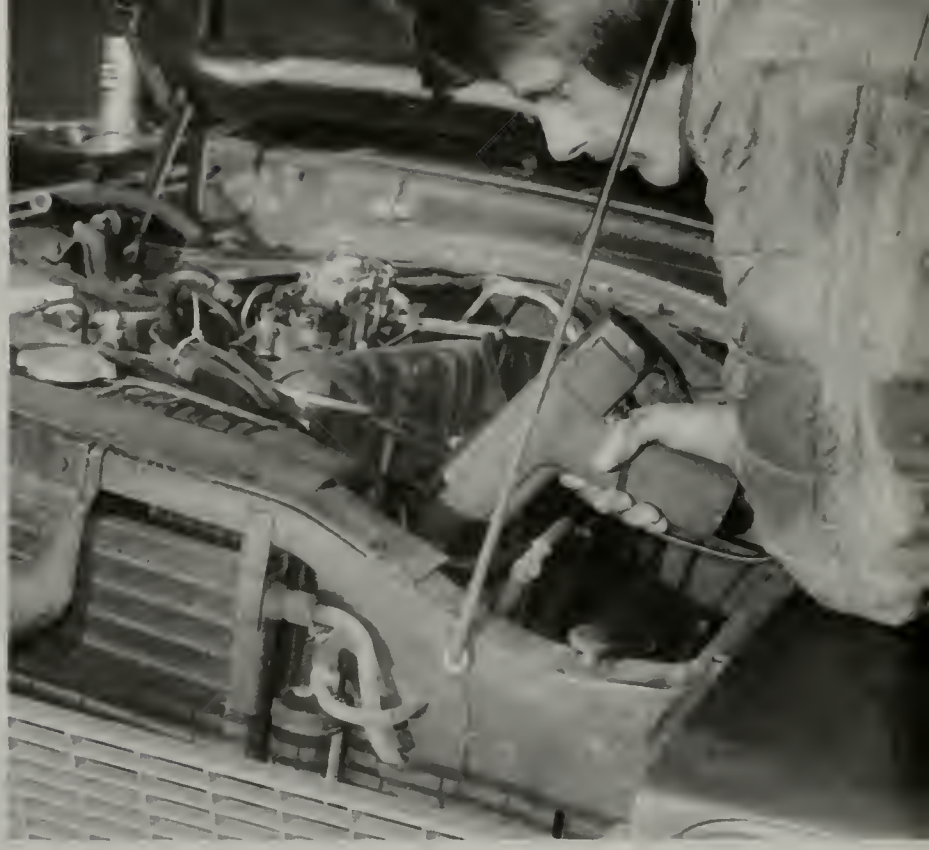
▲ *Trout tastes differ by region. Rainbows in this Black Hills lake took small wet flies, deep.*

They will take your fly down where the fish are . . . fish that aren't going to come up after it. If you are a spin fisherman, here is another hot tip. Get hold of some weighted streamers. These are usually large maribou patterns, with lead bodies. However, they have been outlawed in some places.

The other hottest tip for the brown trout fisherman is this. Wherever it is legal to do so, go out after dark for the really big browns. Wherever there is a curfew, fish as late as you possibly can. The brown is an odd fish in this respect. He seems to imagine himself safe at night. An enormous brown that you could never catch in daylight will come out of his lair at night and fall for even such a monstrosity as a big bass plug.

In your general overall fishing find a few lures that by experience seem to do well for you. Learn how to maneuver these to their very best advantage, and stay with them much of the time. You can learn much about how best to fish a lure by persistently sticking with it, remembering at each catch precisely what you did. Conversely, the fellow who changes lures constantly when things are just a little bit slow may be his own worst enemy—he's fishing none of his lures to their best advantage. B.W.D.

See also: BASS FISHING; FISHING; KNOTS; LURES.



➤ *Timing an engine. Aim light carefully to avoid parallax error.*

Tuning Your Car's Engine

Doing this job properly will take at least four hours of work, but it will pay big dividends in fuel economy, engine performance and driving comfort

A GOOD TUNE-UP CAN DO wonders for a car in the areas of easier starting, smooth idle, better acceleration and higher gas mileage.

Initial checks. To gain performance by tuning, the best place to gain is with a compression test.

If the compression test shows good results, the engine can be tuned. If compression is very high in some cylinder, the cause is probably a carbon accumulation. If compression is uniformly low, there are two possibilities:

1. The condition is normal. Many high-performance engines have camshafts designed for high-speed performance. Compression during cranking will not be particularly high; in fact, it may be as low as 75 psi.
2. There is wear in the engine, either worn rings or valve guides or valves.

The whole point of this initial checking is: Don't expect too much from the best of tuning, unless the cylinders all have close to the same compression.

Inspect the electrical circuits. Clean and

tv cabinet: see bookcase
two-cycle engines: see engines, small
two-place chaise: see chaise
ultraviolet light: see fluorescent lighting
underground sewage drains: see drains

tighten all the battery terminals and fill battery with water. Then follow the ground and starter cables and tighten the other ends to ensure that your ignition is getting all the current it requires for perfect performance. A number of domestic and imported cars have more than one ground strap connecting the engine to the frame or body. It's well worth your time to check these out for tightness and electrical conductivity.

Also check and clean and tighten if necessary, the thin-wire connections at the coil and the external thin-wire connection (if there is one) on the distributor from the coil. On many distributors, the wire goes through a rubber grommet into the distributor itself, and the cap must be removed to check its tightness.

Checking the distributor. First disconnect one spark plug wire at a time from the plugs and, with the engine idling, hold the terminal of the disconnected wire about ¼-inch away from a good ground such as the shell of the plug or a cylinder-head bolt. A good "fat" spark should jump regularly from wire to ground. If the wires have rubber protectors over the ends which cannot be slid back, place a key in the end of the terminal to make contact with the end of the wire and let the spark jump from the key to the ground.

To avoid getting a shock when testing each spark plug wire, have someone start and turn off the engine each time you disconnect a wire, or use pliers with insulated handles to place the key into the rubber socket.

If you get a very weak spark or none at all from one of the wires, it could be due to a wet or dirty distributor cap, a worn or burned rotor or the wire itself, which may have worn spots in the insulation or make poor contact in the cap.

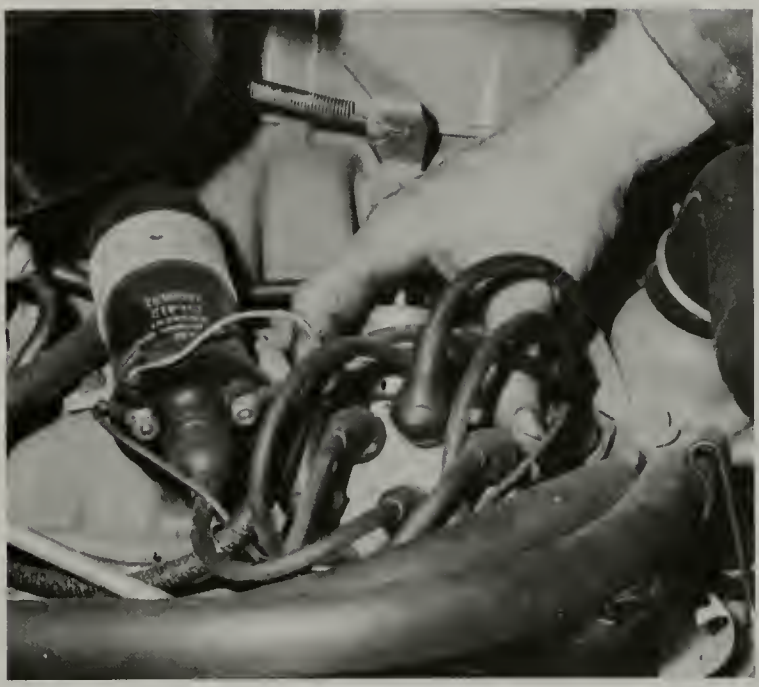
Take off the distributor cap without disconnecting any wires. On most cars the cap is held by two spring clips. On many late-model cars it is held by two spring-loaded locking rods with screw-slot heads.

To undo the locking rod type, press down with the screwdriver and turn to twist the locking rod out of its engagement point in the distributor body.

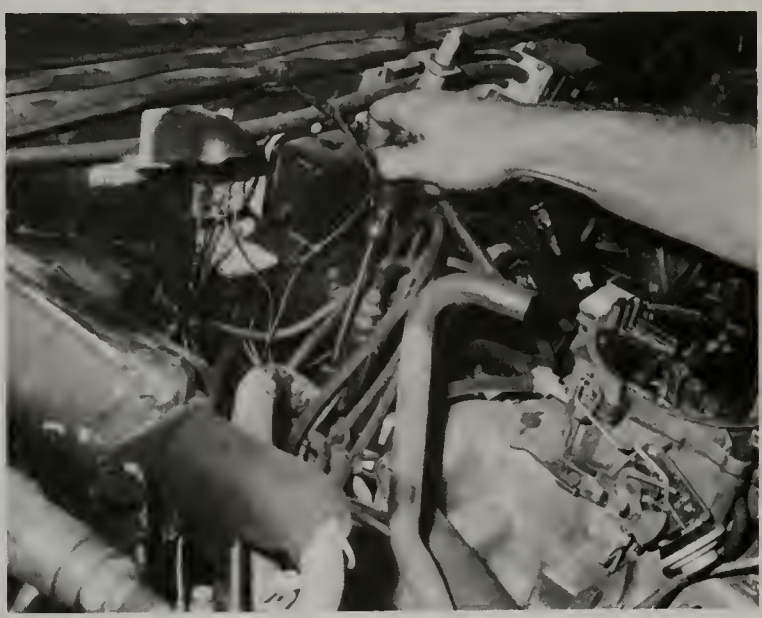
Wipe the cap clean, both inside and out, with a dry cloth. Carefully inspect the inside of the cap for cracks or carbon deposits along a crack extending from one contact point to another. Carbon deposits, particularly on caps having a smooth inner surface, can conduct electricity and cause engine "miss."

Either replace the cracked cap with a

➤ *Spark check on plug wires with recessed terminals can be made by inserting key into terminals, as shown.*



Check thin-wire terminals at coil for tightness.



Distributor cap held by locking rods can be released with screwdriver. Press down on rod and turn to release.

new one or, for an emergency repair, scrape off the carbon along the crack with the point of a knife blade. Seal the scraped-out crack with lacquer or a dab of nail polish to prevent future carbon deposits.

While you have the distributor cap off, remove the rotor, and carefully inspect the tip. If it is burned and pitted so that the edge is irregular, replace it with a new one. Any attempt to file the edge clean would

➤ *Carefully inspect interior of distributor cap for cracks.*

➤ *Removing rotor. On GM cars with V-8 (illustrated), rotor is held by two screws.*

increase the gap between roto and cap terminals and interfere with delivery of a good hot spark to the plugs.

Distributor point failure is sometimes due to oil being thrown on the point contact surfaces by the rotating cam. If you notice a black oily smear on the point support plate, called the breaker plate, it is evidence that oil is getting on the points and interfering with engine performance.

If the distributor has not been cleaned in tens of thousands of miles, some oil accumulation is to be expected and can be cleaned off. However, under normal circumstances, the oil is evidence of a worn bushing around the distributor shaft.

The only cure is to have a new bushing installed at a machine shop or to install a rebuilt distributor. (This is the simplest and quickest procedure.)

Installing points. With the rotor off and out of the way, spread apart the points with a screwdriver and inspect the little discs which make and break the ignition circuit to create the high-voltage electricity for the spark plugs.

If they are pitted or burned, they should be replaced. Points normally last 10,000 to 15,000 miles, but in short trip driving, they may burn more quickly. If points fail in very low mileage, such as 4,000 or so, this indicates that something is wrong.

Reasons for burnt points. You'll be wise to do more than merely replace badly burned contact points. Check for the cause among these six common troubles:

1. Coil resistance unit not properly connected into the circuit between ignition switch and the coil positive.
2. Defective condenser.
3. Points do not open wide enough.
4. Oil vapor may seep into the distributor and get on contact points to cause arcing and rapid burning. A smudge line on breaker plate under the points is a clue to this.
5. High-voltage condition may cause excessive flow through points and produce a blue scale on the points.
6. Radio capacitor connected to distributor terminal may cause excessive pitting.

Replacing the points varies slightly according to the make of car. To start, become familiar with the action of the points by watching them as someone cranks the engine.

You will see the points open and close. They will open as a little fiber block on the point assembly comes up against high spots on the distributor shaft. (This section of high spots is called the cam and the high spots themselves are called lobes.) The points will close as the fiber block comes off a high spot.

Actually only one point moves (out and back). The other is stationary.

Each of the lobes is shaped exactly the same (except on Volkswagen and Buick V-6 engines), so the points are separated exactly the same distance each time. That distance is measured with a feeler gauge and should be at factory specifications.

Removing the points is very easy. If there is a wire connected to the points, disconnect it. Then look for a lockscrew holding the points to the distributor breaker plate under them. If there is more than one screw, the larger one is the lockscrew, Remove it and its lockwasher, and you can lift the points up and out.

Install the new points in the same position, but don't tighten the lockscrew except on General Motors V-8 distributors, as explained later.

The points now must be adjusted.

On all but General Motors V-8 distributors, there is a special tool to simplify point adjustment. It consists of a special ring that fits over the distributor cam and a special feeler gauge that is actually thinner than the size stamping says it is.

The point gap is measured in thousandths of an inch when the fiber block is at a high spot of the distributor cam, and this means the highest point. To get the distributor shaft properly lined up requires cranking the engine in very short bursts—a sometimes time-consuming feat.

The ring simulates the condition and the feeler gauge that is provided with the ring is thinner to compensate for the thickness of the ring.

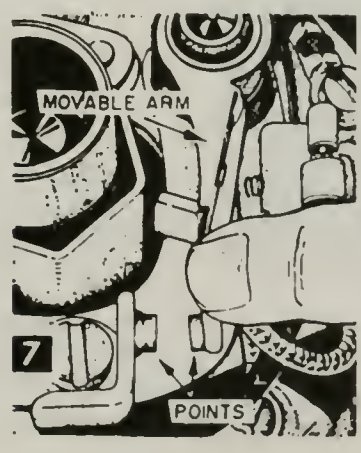
On GM V-8 distributors, the mechanical

Typical Ford and Chrysler distributor. This type of rotor is just pulled off. Notice adjusting screw just below points, and the elongated hole in the ignition point through which it goes. To adjust points, loosen lockscrew and this adjusting screw, and move fixed point toward or away from distributor cam to adjust points gap. When gap is correct, as measured by feeler gauge, tighten the two screws.

advance mechanism is at the top of the distributor and there is no way to fit a ring over it. You will have to either crank the engine or use the special technique explained later.

To measure a point gap, insert the correct size stamped on the gauge feeler gauge between the points' contact faces. If the gauge can be inserted and withdrawn with light drag on it, the gap is correct. If the gap is too wide or too narrow, it must be changed.

Points can be inspected for burning by spreading them apart with finger.



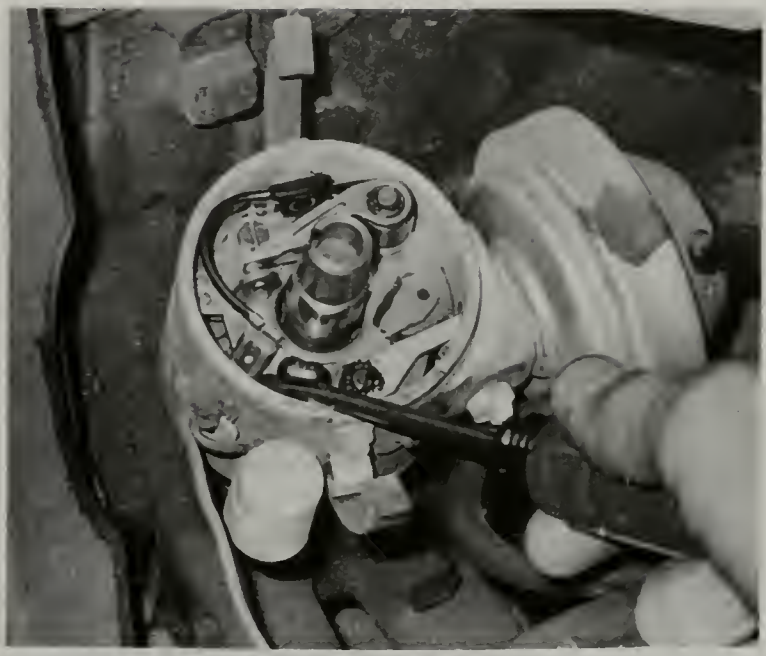
The adjustment is made by moving the stationary point in toward the distributor cam. Sometimes there is an eccentric screw that does this when turned. Other times there is a screwdriver slot in the breaker plate and the stationary point plate and you just twist the screwdriver to increase or decrease the gap.

Once the gap is correct, tighten the lockscrew.

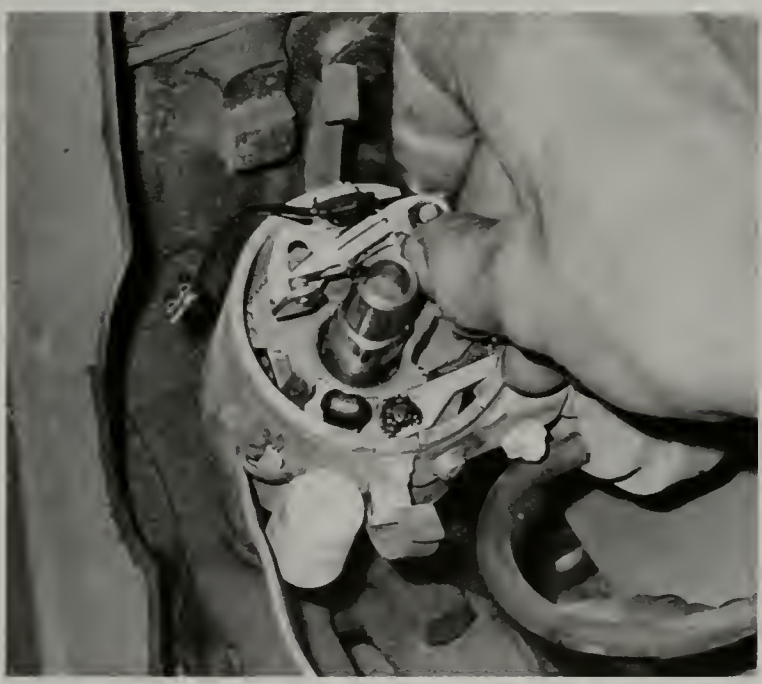
On GM cars with the mechanical advance at the top of the distributor, the following technique will work:

There is an Allen-head adjusting screw at the side of the points and all you have to do is have someone crank the engine while you turn it, until you can see a small gap (about the thickness of a matchbook cover). With this gap, the engine should start, even if it runs poorly.

Refit the rotor and distributor cap, which



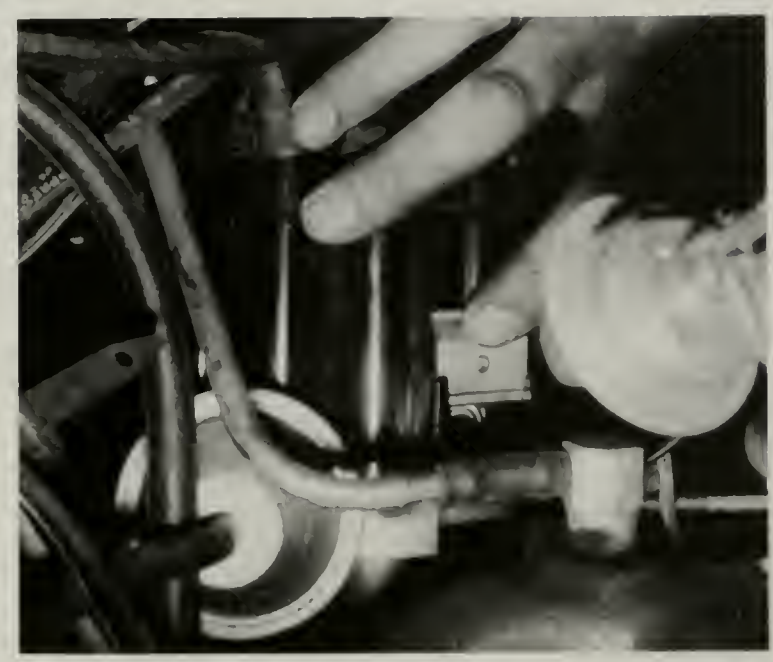
Removing points on this typical distributor starts with disconnecting push-on connector with screwdriver, as shown.



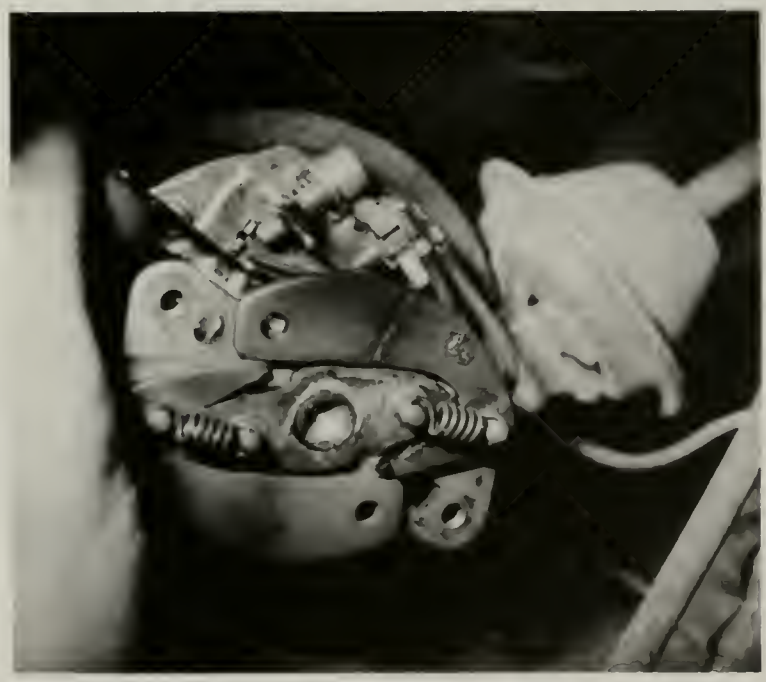
Remove adjusting and lock screws and just pull the points out, as shown.

has a little metal window in its side. This window can be lifted while the engine is running to permit adjustment of the points.

Note: on GM cars with the windshield antenna, there is a metal shield around the points to prevent them from interfering with radio reception. This shield, a two-piece assembly, should be refitted.

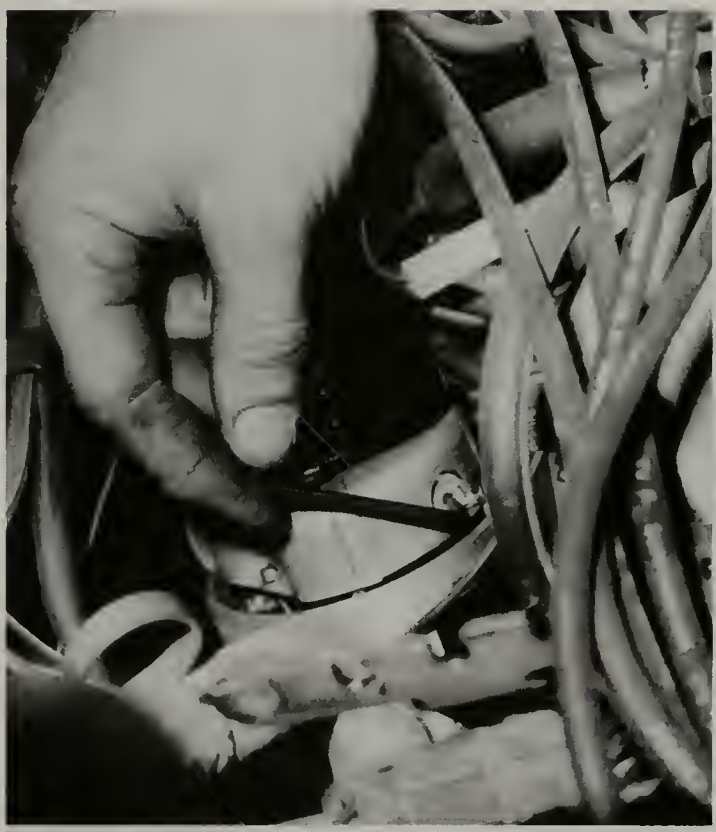


➤ *On GM V-8's, point gap is set with engine running. Lift up window on distributor cap, as shown, and insert Allen wrench.*



➤ *Point gap is adjusted by inserting feeler gauge between points with rubbing block on cam lobe, or special ring inserted.*

With the engine running, turn the Allen wrench slowly clockwise until the engine just starts to misfire, then turn it one-half turn counterclockwise to complete the adjustment. (If the engine is running roughly when you first start it, turn the screw first one way, then the other, until it smooths out.)



Distributor cap has been removed to show how Allen wrench fits into adjusting screw on GM V-8 distributors. This distributor has radio interference shield.

After the ignition points are adjusted, they should be double-checked with a dwellmeter, which is available in a combination unit with a tachometer.

The dwellmeter measures the number of degrees that the ignition points are closed. It is the opposite of the point gap, but it also is an important measurement.

For it is when the points are closed that the magnetic field builds up in the coil. If the points aren't closed long enough, the magnetic field will not be strong enough, and when it collapses, the spark it produces will be weak. This is particularly true at high engine speed.

If the points are adjusted for the correct gap, the dwell reading should also be within specifications—but not always, hence the desirability of a dwell check.

Car makers provide an acceptable range of both point gap and dwell readings and you may have to modify the point gap to get the dwell that is necessary.

The dwellmeter is easily connected—one wire to the "CB" or minus terminal of the coil, the other to a good ground. Then the engine is started and run.

At the same time you should make a dwell-holding test, that is, see if the dwell reading remains the same as engine speed increases. Slowly increase engine speed from idle to 1500 rpm and then slowly let it drop back to idle. Never exceed 1500 rpm.

If the dwell varies more than three degrees, the distributor is worn and should be removed for service. See the distributor removal section that follows.

A final check of the distributor is made when setting ignition timing. At that time,

the mechanical and vacuum advance units are tested with a timing light.

Distributor removal. No matter how well you adjust the points, a distributor may not give good performance if considerably worn or inadequately lubricated. A worn shaft or bushing may cause the points to open unevenly. An overgreased distributor may pick up enough dirt to interfere with operation of advance mechanisms.

With such troubles, the distributor must be removed. This isn't difficult; putting back the distributor is another matter, particularly on Ford products.

If you must remove the distributor, here are recommended precautions.

Remove the distributor cap.

Disconnect the wire from the distributor to the coil at the distributor end.

Crank the engine until the rotor points to a convenient reference point on the engine, or perhaps a time of day on an imaginary clock.

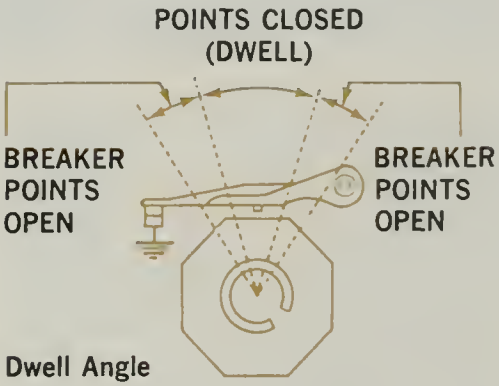
With chalk, mark points on the engine alongside the distributor that align with some portion of the distributor body, such as a cap spring clamp.

Disconnect the vacuum hose or tube.

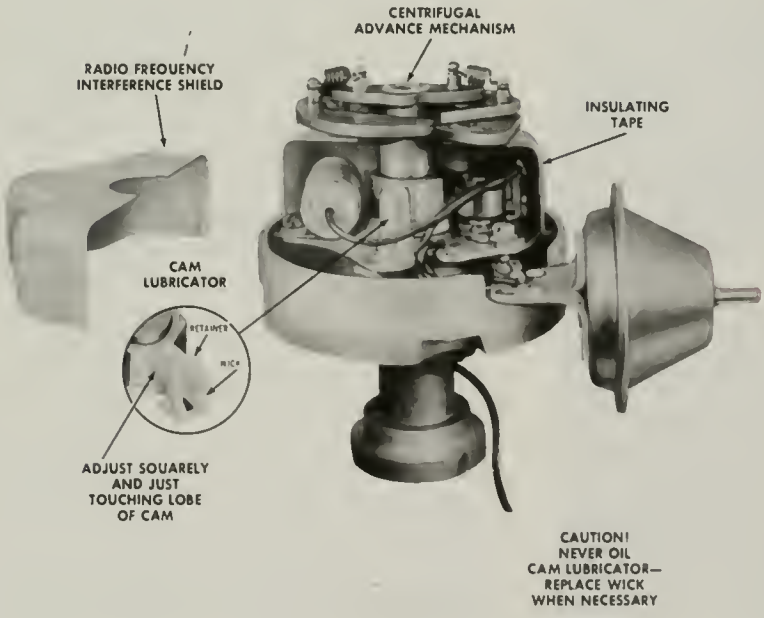
Slacken the distributor lock. It may be a pinch-clamp or a simple hold-down bolt and bracket.

Twist the distributor body as you pull on it, to break any stickiness.

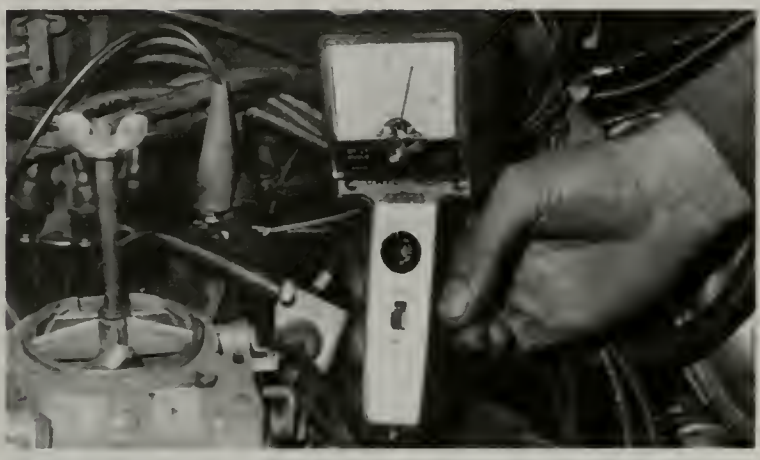
When you install a new or rebuilt distributor, mark the body as you did on the



▲ *Explaining the meaning of the word "dwell," which is the period of time, in degrees, that points are closed.*



◀ *GM cars with windshield antenna have radio interference shield (a two-piece unit) around points. It must be removed to install new points.*



Dwell is checked with special meter, which is normally combined with a tachometer and called a dwell-tachometer. One lead of meter goes to distributor minus (or "CB") thin-wire terminal, other goes to a good ground on engine.

old distributor, and when you get it in, the engine will start.

Timing may or may not be precise, but adjusting timing is a lot easier when the engine is running.

The condenser. The condenser is an integral part of the ignition system. Without it the points would be pitted, burned, and worn in a few days.

In order to force the electrical current to jump the air gap between the spark plug case and the electrode, the relatively insignificant current from the battery must be built up to 20,000 volts or more. The buildup takes place in the primary and secondary windings of the coil. The low-voltage battery current flows into the primary winding of the coil, setting up a magnetic field in the coil. When the voltage is abruptly stopped, the magnetic field collapses and induces a higher voltage in secondary coil windings.

The low-voltage is stopped by the opening of the distributor contact points. The moment the points separate, the current stops flowing from battery to coil. Collapse of the magnetic field not only keys the needed high-voltage induction in the secondary windings of the coil, but also induces, as a by-product, a higher voltage in the primary circuit, a voltage high enough to jump the point gap. If this were allowed to happen, the contact points would soon become useless, and the arcing would drain needed power from the higher secondary voltage.

The condenser saves voltage and points by acting much like a shock absorber that stores energy that otherwise would keep the springs ocillating. The electrons are crowded into the condenser where they continue to build up. As they work, they set up a reverse direction to their flow pattern. Because the points are still open, the flow is toward the grounded side of the condenser. At a point, the buildup collapses and reverses, building up toward the insulated side of the condenser, then the flow and buildup reverses again and again.

Each time the flow is reversed, the magnetic field it creates collapses, then builds up in the opposite direction continuing from side to side until the electrons are dissipated or stopped by closing of the points. The condenser thus helps retard the flow by impeding or blocking the electrons and keeping them where they can do no damage.

Inside your condenser are four strips, two of metal foil and two of insulating paper. Almost 15 feet long, they are rolled tightly (metal foil sheets are slightly narrower than the insulation to prevent leakage of electrons around the edges) and the roll is placed in a metal case. The case is

➤ *Distributor removal starts with disconnection of vacuum line. On many cars it's a hose that can be pulled off; on this one it's a tube.*

➤ *Next, loosen distributor lock. On most cars, it's a bolt and bracket to engine. On this car it's a pinch-bolt.*

➤ *Pull distributor out with twisting motion to break it free.*

hermetically sealed to shut out moisture—the enemy of a condenser.

One foil strip is connected to the cap of the condenser and an exterior terminal. The second is connected internally to the condenser case. A pigtail soldered to the outside terminal connects to the primary distributor terminal, placing the condenser in parallel. The case acts as ground so the condenser is wired across the circuit.

Automotive condensers are rated in microfarads. It is important to replace a defective condenser with one of the proper rating for your car.

Although the condenser in your car is a reliable, long-lasting item, trouble could strike when least expected. A weak or leaking condenser usually has absorbed enough moisture to weaken the insulating papers and can no longer hold the buildup charge it was designed to handle. A condenser with poor insulation can drain enough energy from an ignition system to lower the secondary voltage substantially. A weak or intermittent spark at the plugs can be a disastrous result.

Signs of trouble may go unnoticed except when the engine is hot. It is unlikely a leaking condenser would cause misfiring at low or medium speeds, except under conditions which cause it to heat.

Frayed pigtail, broken terminal, or loose insulation can all increase point wear. Under severe conditions, they can render the points useless. If you're experiencing ignition trouble, burned points, hard starting, check the condenser. Remove it from the distributor. Check for broken leads, frayed or loose insulation, corroded terminals, signs of moisture, or poor ground at the mounting.

Some simple tests. Condensers are generally tested on equipment giving three readings: microfarads, leakage, and series resistance. But test equipment costs money and condensers cost but a few pennies. You'll be money ahead if you make these few simple tests; then if the condenser seems faulty or if you're in doubt, replace it and test again.

A condenser can be tested for excessive leakage (short) by charging it from a spark plug as the engine is turned over. Be sure the spark used for the test has a gap no greater than .030. The small gap will limit the voltage involved.

Ground the condenser case to the cylinder head or block, then touch it to the plug terminals. Remove the plug, turn off the engine, and wait one minute. With a *well-insulated* screwdriver, short the condenser terminal to the outer case. One heavy spark should result. If the condenser will not hold such a charge for one minute, it should be replaced.

Caution: Charged in this manner, a condenser can give you a severe shock. A plug gapped to .030-inch and operating in low compression with the engine at idle will develop about 300 volts. This is not enough to injure the condenser insulation, but plenty "hot" if you touch it. Be sure the screwdriver is well insulated before you short the condenser.

A safer test is to check the condenser with the coil. Remove the high tension lead from the coil terminal and fit a 12-inch jumper wire to the terminal. Now make certain you are properly insulated from the jumper wire, then turn on the ignition switch and hold the open end about ¼-inch from the cylinder head as the engine is cranked. If a spark leaps across the gap regularly, coil and condenser are OK. If there is no spark, or if it is weak or irregular, either the coil or condenser are at fault.

Replace the condenser and repeat the test. If there is still no spark, the trouble lies in the coil. If the spark now jumps the gap, the condenser was at fault and the trouble has been fixed.

Another test of a condenser is for internal grounding. Disconnect the condenser wire and connect a test lamp or jumper

➤ *Condenser can be tested for grounding with test lamp. Disconnect condenser lead and attach alligator clip of lamp to it. Turn on ignition and touch prod of test lamp to ignition points terminal. If lamp lights, condenser is internally grounded and should be replaced.*

wire to it. Touch the other end of the test lamp or jumper wire against the battery's starter terminal. If the test lamp should light, or the jumper wire should spark, the condenser is defective and should be replaced.

Setting ignition timing. For this you will need a power timing light. There are inexpensive versions that plug into a household outlet, and for weekend mechanics they are adequate.

Totally inadequate is the neon bulb timing light. It just is not bright enough, and on today's cars you can't get it close enough to the timing marks without risk to your hands.

Timing is set with the engine at idle or another specified speed, and with the vacuum tube or hose on the distributor disconnected and plugged. Factory timing specifications are based on the disconnected vacuum tube or hose, and you should not try to do the job any other way.

Slacken the distributor locknut, lockbolt, pinch-clamp on whatever is used. Connect the timing light and start the engine. The light will start flashing.

Aim the light at the timing marks, which are on the crankshaft pulley or vibration damper and a stationary part of the engine adjacent to it.

If timing is off the mark, turn the distributor body until the marks line up. If you can't see the marks, stop the engine and take a look with a flashlight. You may have to short-burst-crank the engine to find the mark on the pulley.

If the marks are covered with road film (and they shouldn't be if you keep your engine clean), wipe them off. You may find several marks, and you will have to check manufacturer's specifications to find out which are the correct ones for your car. If necessary, mark them with chalk.

Once you have the distributor body positioned so that the marks line up, tighten the locking arrangement (bolt, nut, clamp). Now speed up the engine and the timing

should advance. If it does not, the mechanical advance mechanism in the distributor is defective. On General Motors V-8's, the mechanical advance is above the points (just below the rotor) and you can easily see if a spring has come off, or stretched. On other distributors the breaker plate must be removed.

Keep the timing light on the marks and reconnect the vacuum tube or hose. With the engine running at idle speed or slightly above, the timing should advance as soon as the tube or hose is back on. The advance in timing will also cause the engine to speed up a bit. If the timing does not change, the vacuum advance unit is stuck and should be replaced. This can be done on the car in most cases.

Wiring. From the coil to distributor, and from distributor to spark plugs is a mare's-nest of most important wiring. These high tension wires should be firmly soft. If they are hard, cracked, or gooey with oil, replace them all. Cost is low for a new set of high tension wiring, and the results are well worth your trouble. A little cleaning fluid on a clean rag does a good job of wiping off the top of the coil, so electricity can't sneak out of the wires and lose itself to ground.

Check your spark plugs.

Nuts and bolts are next. Use a good set of wrenches to tighten all on the manifold (both intake and exhaust) carburetor attachment, and other odds and ends of hex-headed objects you can find. After thousands of miles of vibration they loosen. Leaking intake manifolds could burn plugs or valves, as well as destroy efficiency of the fuel mixture.

Cylinder head bolts should also be tightened, but this job must be done with a torque wrench.

As you well know, exhaust fumes are both dangerous and unpleasant, which makes a tight exhaust manifold a blessing and a necessity.

Other steps in tuning for power are:

1. Adjusting valves.
2. Servicing the heat riser.
3. Replacing or servicing the air filter.
4. Servicing the hardware installed for smog control.

Road testing the car. This is done in the following sequence: In high, run along a level road at some 10 mph. The engine should pull evenly, without surge or hesitation. Should it not be smooth, work the idle mixture needles until you have as smooth an idle as possible.

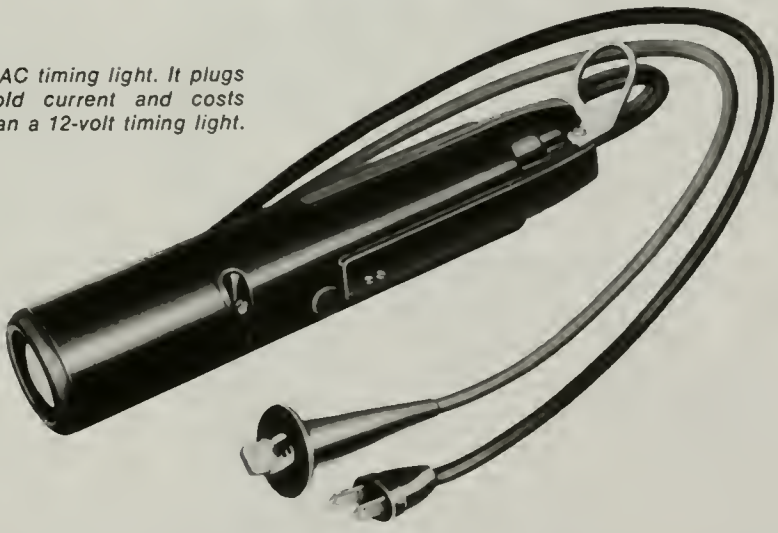
Gradual acceleration resulting from a slow even pressure on the throttle is the next check. During this one, you should have even acceleration, without hesitation or leaping forward. Try this several times, paying close attention to evenness of the speed increase. You will then notice that between 40 and 60 mph there will be a sudden surge forward, though you have not moved your foot that much. Action in the engine room comes from the opening of the power valve(s) or secondary throttle blades. All of this is controlled by engine vacuum and position of your foot.

There's more fun to the third checkout. While running 20 to 25 mph, floor the throttle. Here you want a smooth, even increase in speed. Again, lack of flat spots is the most important thing. Should the engine seem to gasp once or twice when you floor the throttle, try moving the accelerator pump lever to another hole. This modifies the amount of fuel pumped into the engine and is an adjustment worth making. Make this test several times so you'll have a good idea how well an engine can run. Then as performance changes when the engine ages, you'll be in a better position to determine when another tuning is needed.

The last test is to hold the throttle in a steady position at 40 to 50 mph on a flat road. Here is where smoothness is the top dog. The engine should keep you rolling at

When setting ignition timing, always disconnect vacuum line from distributor and plug the line. (A golf tee makes a suitable plug.)

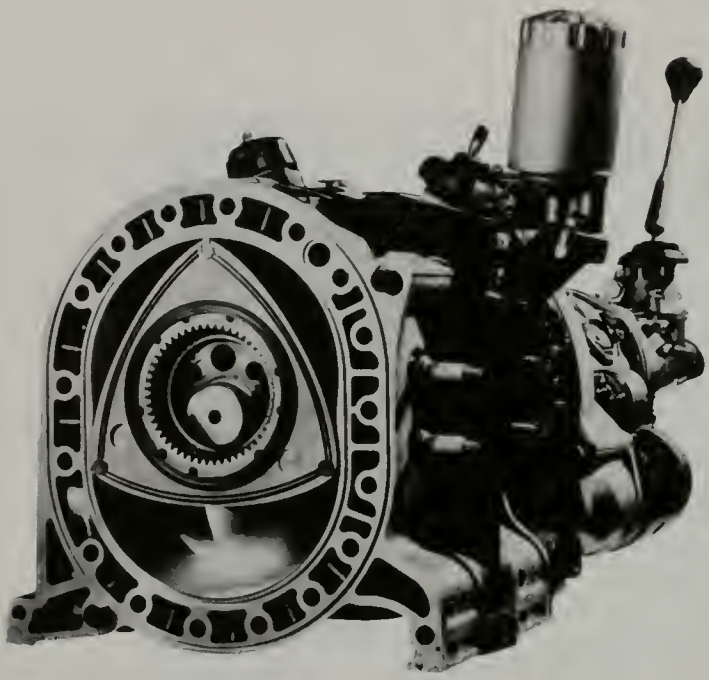
This is an AC timing light. It plugs into household current and costs much less than a 12-volt timing light.



an even pace. If not, the carburetor float level may be off, or the vacuum line to the distributor could be leaking enough to cause spark advance to wander.

One thing is certain—after you've spent the necessary four hours making a thorough tune-up, you will have an engine that outperforms most others of its type. It will also run smoother and be more pleasant to drive, while giving you better fuel mileage than ever before. P.W.

See also: AIR CLEANERS; ANTI-POLLUTION; ELECTRICAL, AUTO; ENGINE; FILTERS; HAND TOOLS; HEAT RISER, AUTO; IGNITION SYSTEM AUTO; PARTS REPLACEMENT, ENGINE; REPAIRS, AUTOMOBILE; SPARK PLUGS; TRANSMISSION, AUTO; VACUUM GAUGE.



How to Tune a Wankel Engine

Don't be overwhelmed by the rotary engine just because it's new and different. Except for the rotor orbiting in the chamber, every part is the same as it is on a standard piston engine

THE WANKEL IS AN ENGINE that could make weekend mechanics fun again, although it probably has most Saturday wrench twirlers petrified at the thought of servicing it.

Yes, the Wankel is different in that it has no pistons, rings or valve train. Instead, a rotor takes an eccentric path through a chamber, relying on seals as its three tips to form areas in which fuel and air are admitted, compressed, burned and expelled as exhaust.

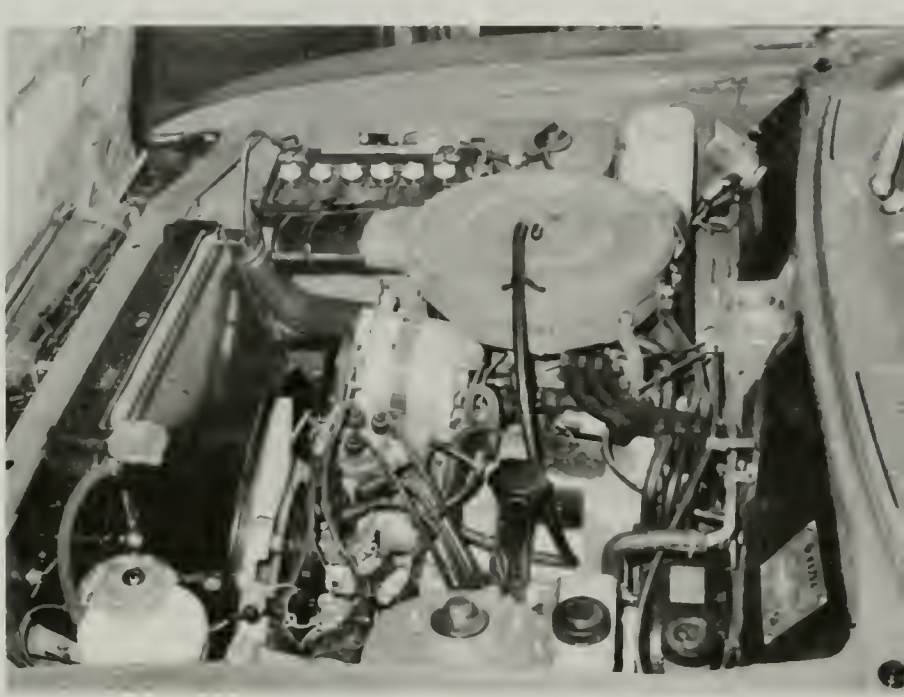
Don't be overly concerned about the engine's innards. If you're a typical weekend mechanic, you're doing tune-ups, cooling system work, oil changes, filter replacement, brake jobs and the like. You probably haven't done an engine overhaul on a piston power-plant, so why worry if you can do one on a Wankel? The Japanese Mazda is the only production car with a Wankel engine at this time, and its engine is doubtlessly typical of what to expect for the most part. It has a double chamber and two rotors—sort of two Wankels joined together.

Lift the hood of a Mazda and the first thing you'll see is lots of room. The Wankel is about half the size of a comparable-performance piston engine, so you'll find that there's plenty of room for even oversize hands and arms, and the physically larger, conventionally-shaped wrenches and other tools that the weekend mechanic is most likely to have. In short, few special tools are needed.

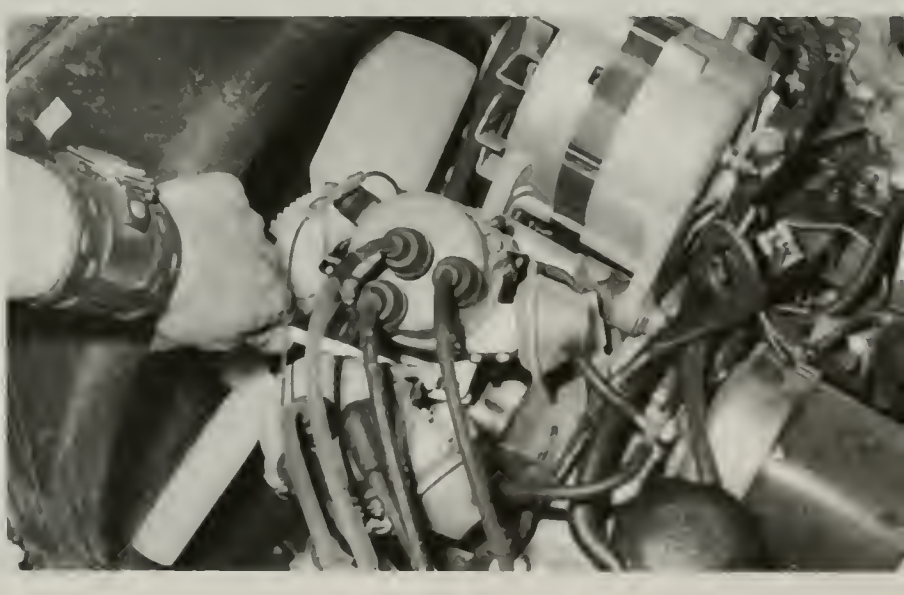
Actual maintenance work on the Wankel is not much different from the piston engine. The air filter sits in a housing under a cover held by a few spring clips. The filter

is a standard pleated paper element and replacing it is exactly the same as on a piston engine.

The Mazda Wankel may be a bit more sensitive to a clogged air filter element, however. The carburetor used in the Mazda has secondary throttles controlled by vacuum demand (somewhat similar to the GM Quadra-Jet carburetor). That is, the secondary throttles are linked to a vacuum diaphragm, and when there is high vacuum in the venturi of the primary throttles, and



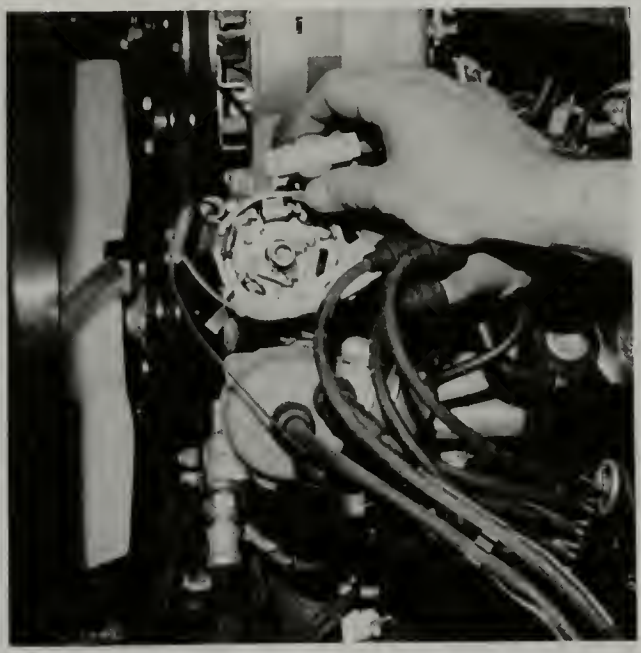
➤ *At their first glance under the hood, most people won't even notice that the Mazda has anything unusual for an engine. Air cleaner, generator, oil filter and both distributors are right up top with room to spare.*



➤ *The lock nuts for the distributors are easily reached with a box-end wrench. When nut is slackened, timing can be adjusted by rotating the distributor in usual way.*

when the primaries are opened 50 degrees or more (which releases a lockout), the secondaries pop open.

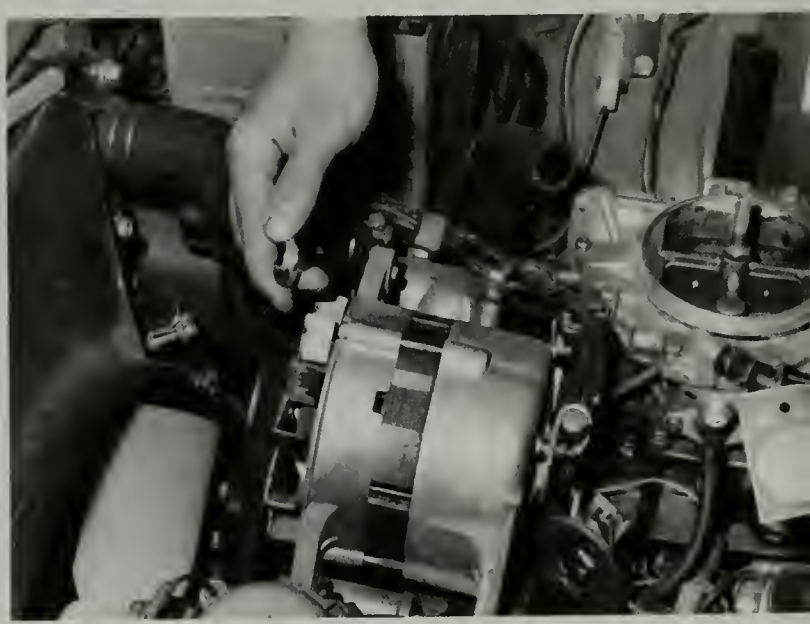
Normally, this occurs only under heavy load, which is when you need the secondaries. However, a plugged filter also creates high vacuum, and the primary throttles must be opened past the lockout position to overcome the restriction posed by the clogged filter. Result: the secondaries pop open and the engine suddenly speeds up—a condition called runaway. This uncontrolled speedup may occur during normal operation at medium road speeds, or when starting with the throttle cracked open sufficiently. It takes a really plugged filter to cause runaway, and the careful weekend mechanic who changes his filter once a year should never encounter it.



The Mazda air filter housing cover is different in that it holds the charcoal canister for the gasoline evaporative emission control system used on most cars. The charcoal canister is affixed to the underside of the cover, and it removes easily for replacement.

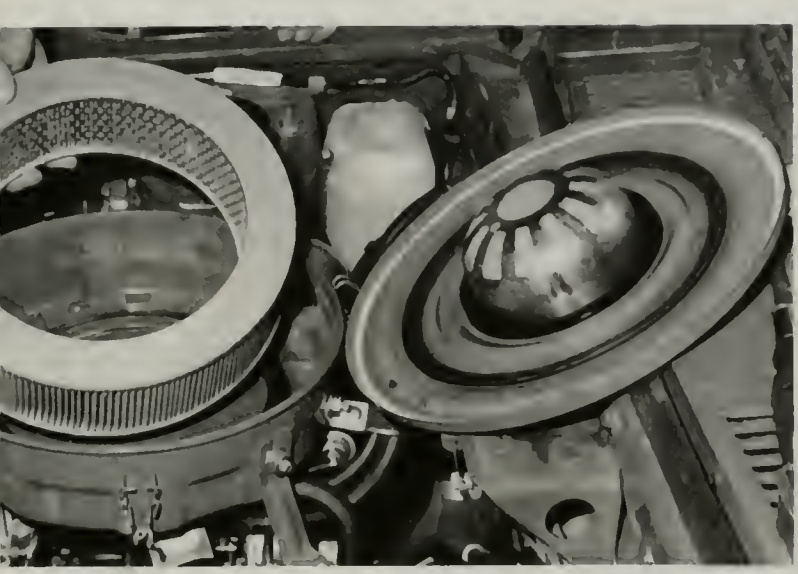
The Mazda oil filter is a conventional design spin-on, and it's so completely accessible on top of the engine that even an absolute beginner should have no difficulty in replacing it.

Most other external engine components are quite similar to those on a piston engine.



▲ *Points, condenser and rotor are replaced and/or adjusted as on any other car. On the Mazda, of course, you simply have to do the job twice. Remember that there are two sets of timing marks, one for each distributor. Make sure you're working with the right set before you make any changes in the timing.*

➤ *Alternator bracket is within easy reach for belt adjustment.*



Changing the air filter remains the simple task that it is on most cars. Release four clips on the housing and the top is easily removed. Note that charcoal canister for evaporative emission control is safely and sensibly located on the underside of the housing's top. A clean air filter is very important with Mazda's 4-barrel carburetor.

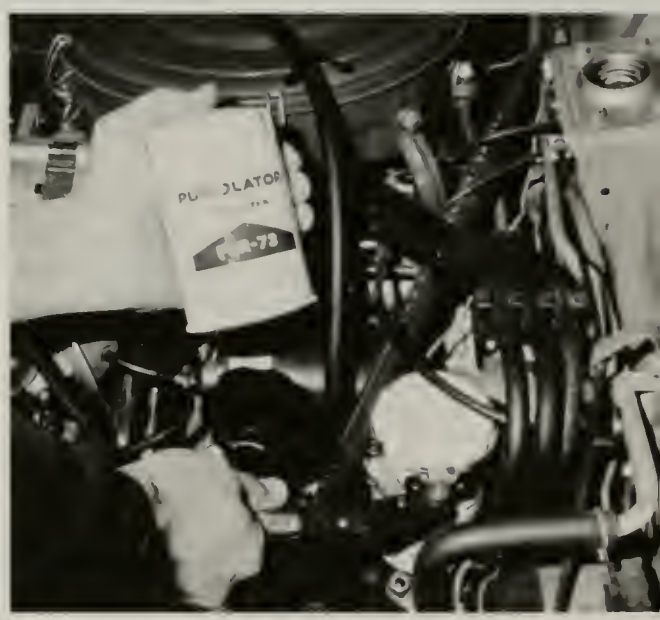
The Mazda Wankel, for example, has an alternator driven by a conventional fan belt, a battery, cables, starter (also on top of the engine), a water pump, radiator and hoses, a pressure cap and ignition system.

The Mazda Wankel ignition system is slightly different, but nothing to really turn anyone off. There are four spark plugs, two for each rotor of the twin-rotor engine. One spark plug at each rotor is called the leading plug, the other the trailing plug, and together they produce a combustion pattern that provides maximum power and driveability. The trailing plugs are shorted out under certain conditions when the engine is warm, to reduce exhaust emissions.

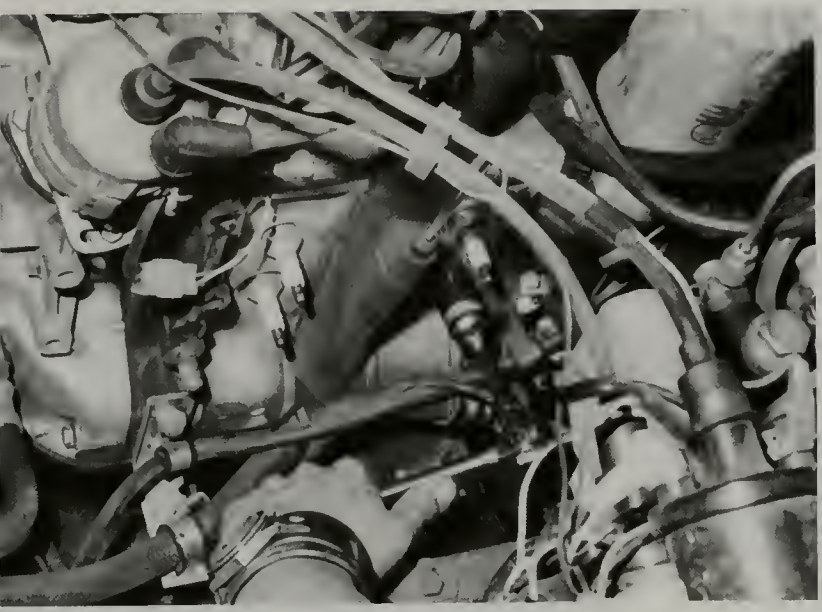
Replacement of the spark plugs is easy. They're on the left side of the engine and there's plenty of working room.

The Mazda Wankel has two distributors, one to fire the leading plugs, the other to fire the trailing plugs. Each distributor has its own breaker points, condenser, vacuum and centrifugal advance mechanisms and each is fed from its own coil. Advance mechanisms and coils are not interchangeable from one distributor to the other.

Each distributor has its own timing mark, so when you check timing with a strobe light, be sure you've got the right mark. Because the trailing plugs' distributor may be shorted out when the engine is warm, you should check timing when the engine is cold. A cold engine is similarly correct for



Oil filter is mounted vertically on the highest point on the engine block and there's plenty of room for a wrench, so even a beginner should have no problem changing filters.



On models without air conditioning, the Mazda's four spark plugs are easy to reach although they are pretty far down on the engine block. On air-conditioned cars, the compressor takes up a lot of space alongside the distributors, so you'll probably need a ratchet wrench with a long handle to get at the plugs.

An in-line gasoline filter is located near the gas tank in the Mazda and is reached for replacement through a small panel in the trunk floor. The pleated paper filter element is similar to many used in piston engine cars and any one that fits is an adequate replacement —you don't need an original equipment filter.

the popular spark test on the trailing plugs' distributor (pulling the thick coil wire from the distributor cap, holding it near a ground, and cranking the engine to see if it is discharging a spark).

Changing of points and condenser, and setting point gap, although it has to be done twice, poses no special problem.

Compression testing a Wankel before installing new plugs and points can be done with a standard compression gauge, although Mazda doesn't recommend it. Here are the pros and cons:

Mazda's viewpoint: A compression gauge inserted into a spark plug hole on a piston engine is measuring only one cylinder. On a Mazda Wankel, the objective is to measure the compression created by each tip seal. Because the piston engine compression gauge has a Shrader valve that holds the dial needle at the highest reading, the result on a Wankel engine is a reading that reflects the best tip seals. If the Shrader valve is removed, the gauge will record compression variations, but the needle flutter will be such that it will not be accurately readable. For accurate readings, therefore, only the special gauge recommended by Mazda for the Wankel should be used.

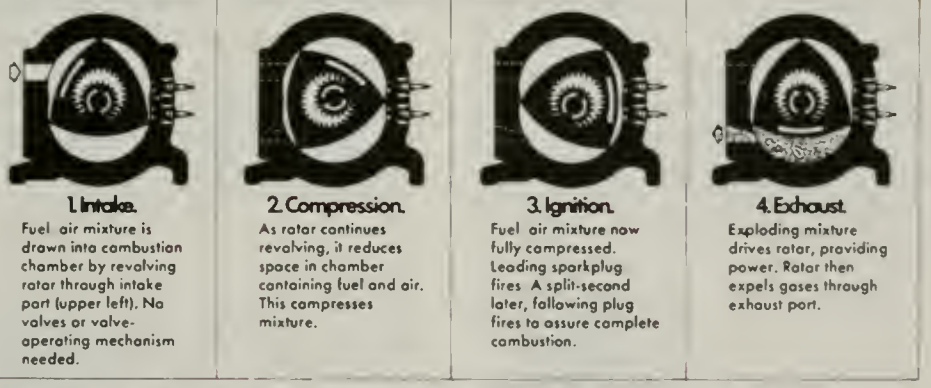
Pro viewpoint: Actually, two of the three

How to Tune a Wankel Engine 2923

➤*The electric fuel pump is mounted near the gas tank inside the left rear fender. Access to the pump, for replacement or testing fuel pressure, is gained by removing a metal plate under the fender.*

➤*A triangular rotor twirls around a stationary central gear like a hula hoop around a child's waist (top). The rotor therefore takes an eccentric path through the chamber, compressing the fuel-air mixture down at the spark plug end (fig. 3, top) and then sweeping the exhaust out the exhaust port (fig. 4, top). While this is taking place on one rotor face, the same sequence is taking place—in turn—on the other two rotor faces, giving three "power strokes" for each revolution of the rotor.*

HOW THE WANKEL WORKS.



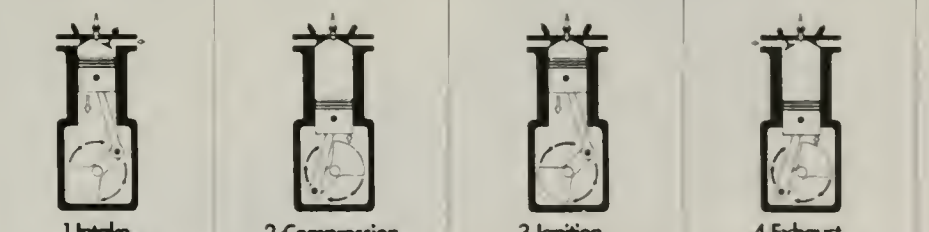
1. Intake.
Fuel air mixture is drawn into combustion chamber by revolving rotor through intake port (upper left). No valves or valve-operating mechanism needed.

2. Compression.
As rotor continues revolving, it reduces space in chamber containing fuel and air. This compresses mixture.

3. Ignition.
Fuel air mixture now fully compressed. Leading sparkplug fires. A split-second later, following plug fires to assure complete combustion.

4. Exhaust.
Exploding mixture drives rotor, providing power. Rotor then expels gases through exhaust port.

HOW A PISTON ENGINE WORKS.



1. Intake. 2. Compression. 3. Ignition. 4. Exhaust.

tip seals are involved in sealing in the compressed air-fuel mixture at any one time. Therefore, the reading with a standard compression gauge is a reasonably reliable indication of tip seal condition. The tip seals all follow the same path in the chamber, so the odds of having one bad seal out of three, without some indication in the form of irregular performance, are low. If the gauge is used merely as an indicator of sound compression in an engine that is showing no weird symptoms, there should be no problem. As for checking compression with the Shrader valve removed, that is an individual matter worth trying before investing in a special tool. If someone can train his eyes to detect excessive needle flutter, he certainly has no need for the Mazda gauge.

The Mazda tune-up should include all the standard items you would check on a piston engine such as air pump belt, fuel pump output and replacement of the in-line gasoline filter.

The Mazda fuel pump is an electric unit mounted near the gas tank, and you can check output and pressure at the pump discharge port. Access to the pump is by removing a bolted-on sheet metal cover at the bottom of the left rear fender. The in-line gasoline filter, a standard pleated-paper element in a plastic canister, is near the pump and is accessible for replacement after removing a cover plate in the trunk compartment. A similar filter made for piston engine cars is a satisfactory replacement—you don't need the original equipment type.

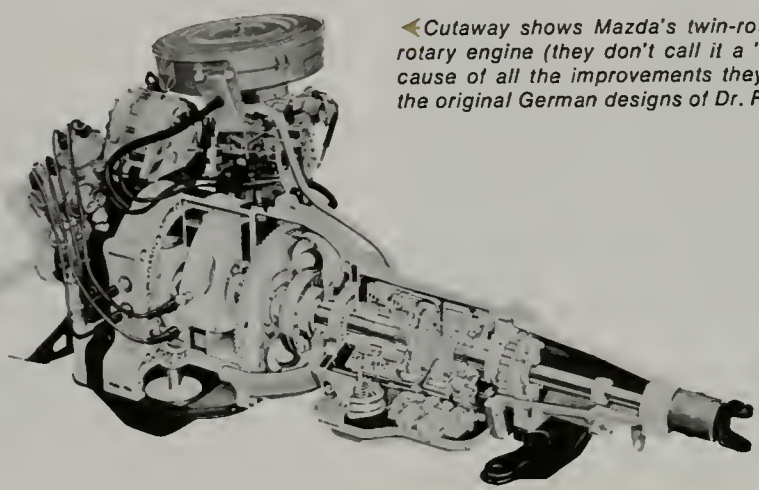
Engine overhaul on the Wankel is beyond the capability of the weekend mechanic at this time, simply because many of the nuances and tricks of the trade are still being determined. For example, fitting of some oil seals must be done very carefully to avoid leaks.

Just as the advanced weekend mechanic learned the ins and outs of piston engine overhaul, however, he will eventually learn the Wankel. Mazda is training professionals in the job in less than a week, and there are lots of amateurs whose only difference from the pro is the lack of speed that is developed in day-to-day work on the engine.

In the meantime, development work is continuing on Wankels with quick-change rotor tip seals. Such a design feature could make the average weekend mechanic more versatile on a Wankel than he is on a piston engine.

Even if Wankel overhaul remains beyond your grasp, you'll find you can do as much of its maintenance as you ever did on a piston engine—with less sweat. P.W.

See also: AUTOMOBILE ENGINES, ADVANCES IN.



Cutaway shows Mazda's twin-rotor, four-plug rotary engine (they don't call it a "Wankel" because of all the improvements they've made on the original German designs of Dr. Felix Wankel).

How to Enamel Unfinished Furniture

The easiest way to finish unfinished furniture is with two coats of gloss or semi-gloss enamel

UNFINISHED FURNITURE may be stained or enameled, but the beginner is better off tackling enameling first—preferably a bookcase or other small section. Also, this furniture is not particularly suited for staining or "clear" finishing with shellac or unpigmented lacquer. The reason is that the furniture is built of solid lumber consisting of glued-up boards widths, and when clear lacquer or shellac is applied the variation in the color of the boards is accentuated—especially where they are joined.

Before starting the enameling project, decide on the color shade and also on whether you want a high-gloss or satin finish. Enamel is available in a wide variety of colors, or you can buy white enamel and color it with pigment from tubes to suit yourself. Any quality enamel of a reputable brand can be used. The undercoating or "primer" should be of the same brand as the finish enamel.

Start by removing all drawers and hardware; these are finished separately.

Then "clean" the wood. Unfinished furniture comes pre-sanded, but is is essential that you go over it again to remove surface fibers and smooth rough spots. Use a fairly coarse sandpaper at first—such as 2/0 garnet cabinet paper—held across a block of wood or fitted in one of the commercial sandpaper holders. An electric sander isn't necessary—and by no means use a disc sander; this will just gouge and score the wood.

Apply the sandpaper firmly, working only with the grain. Follow up by smooth-

➤ *Unfinished furniture is sanded before being sold, but not so smoothly that you can go right ahead and enamel it. Sections should be carefully hand-sanded to smooth out the rough spots missed at the factory. Use a sanding block or commercial holder as shown. Start with 2/0 sandpaper, finish with a 4/0 grit.*

➤ *Undercoat goes on first; tint it the same color as final coat. Work brush in a straight line with the grain.*

➤ *Follow the same technique when enameling, but apply less pressure.*

➤ *Hardware such as drawer pulls can be enameled, then set upright to dry in holes drilled in scrap stock.*

Very lightly "feathering" the end of a piece of work eliminates brush marks.

Feathering will also follow initial heavy brushing that is required to fill in grooves of cabinet door.

sanding with finer 4/0 paper, then dust the funiture carefully with a soft, dry brush. Finally, wipe all surfaces with a clean cloth.

Now you are ready to apply the enamel undercoat. This should be tinted approximately the same color as the surface coat by adding pigment from a tube.

Use a quality-bristle brush 3 or 4 inches wide for applying the enamel when the undercoat has dried. Dip the brush in the can to a depth of about an inch, then apply the enamel to the surface, brushing out the paint in straight lines along the grain. Stay in one line at a time, working in the enamel thoroughly until it is spread evenly and the brush seems almost dry.

It is important to develop the right stroke with the brush. Move it in a single stroke from near one edge clear across the work until the brush leaves the other end; then repeat the stroke from the other side. The final strokes should be done with the tips of the bristles, holding the almost-dry brush at a right angle to the work and applying very little pressure.

When this stage of the work is completed, leave the furniture to dry overnight. Keep all windows closed so that no dust will blow on the wet paint. Wash out brushes in turpentine or solvent, then rinse them in sudsy water. Wrap the brushes in heavy Kraft paper until they are ready to be used again.

Before the final coat is applied, the undercoating (or first enamel coat) must be thoroughly sanded. Use 2/0 sandpaper to remove brush marks, following up with fine 4/0 sandpaper until the surface is perfectly smooth. Then dust carefully.

The final coat is applied in the same manner as the first. Take particular care that the finishing strokes of the brush are very light and straight.

Drawers, drawer hardware and other removable parts are painted separately and replaced only after the entire unit has dried completely.

A clear paste wax may be applied after waiting at least a week for the enamel to dry thoroughly and harden.

See also: ANTIQUING; FINISHING, WOOD; FURNITURE, USED; LUMBER; PAINT; PAINTING; PAINT SPRAYERS; STAINING.

Keep Your Car's Upholstery in Good Condition

Why bother washing and polishing the outside of your car when the interior is a mess? Here's how to keep the inside clean and in good repair

THE BEAUTIFUL OUTSIDE appearance of a carefully washed and waxed automobile is meaningless if the interior does not match.

Fortunately, today's vinyl upholstery is extremely easy to keep clean and, with special products available, also easy to repair and recolor.

Most mild household spray cleaners will do a very nice job on car vinyl upholstery, removing dirt easily, and doing a reasonable job on stains.

If your car's upholstery is beyond quick cleanup, a recoloring is the answer.

There are several brands of recoloring on the market and they work on vinyl, leather and Naugahyde. The recolorings are available both in brush-on or aersol spray form. Generally the brush-on is recommended because it is more economical than the spray, it requires no masking and it can be mixed like paint to the exact shade you want. Each type of recoloring also helps the vinyl resist cracking.

Also available in several brands is a highly effective vinyl upholstery and top repair kit. The material in the kit, a sort of vinyl putty, is available in colors to match original equipment upholstery.

You just trim the ripped area then apply the repair material with a spatula. Smooth over the damaged area with the spatula. Select the proper graining paper. (The kit comes with paper that is embossed to match different car upholstery grains.) Place the graining paper on the damaged area and heat with an iron. Remove the graining paper and you actually will not be able to find the "patch" a week later.

If your car is an older one or an economy model, with broadcloth or flatcloth upholstery, keeping it clean presents some problems.

Broadcloth and flatcloth. Avoid using any solutions containing water on broadcloth no matter how efficiently they remove signs of soiling or stains. Broadcloth finishes are produced by a process employing multiple pressings and other operations which result in the fine finish of this fabric. Water causes the nap to curl and become rough. The result is an unsightly appearance and restoration of the original finish is impossible.

The use of a volatile cleaner is recommended on both flatcloth and broadcloth upholstery. Naphtha or gasoline may be used, but make sure that no coloring or tetraethly lead is contained in the solvent. Since naphtha and gasoline are dangerous as a fire hazard, they should only be used as a last resort when a safer type of cleaner,

urea formaldehyde glue: see adhesives
used furniture: see furniture, used
u-shaped kitchen: see kitchens
utility cabinet: see laundry rooms
utility shelves: see shelves

such as carbon tetrachloride, is not available. Make sure there is plenty of ventilation when using any type of volatile cleaner since the fumes are toxic. Also, remember to wear rubber gloves to protect the skin if it is sensitive to irritation.

After all dust and dirt have been removed from the material, wet a cloth with the volatile cleaner. Spread the cloth open and permit the cleaner to evaporate so that the cloth is just damp. Apply the cloth to the upholstery with a very light pressure and rub over a small area at a time. Change to a clean portion of the cloth every few strokes.

If the material is to be gone over again, give it time to dry thoroughly. This will prevent the solvent from penetrating to the padding underneath. Avoid soaking or heavily wetting the upholstery with any volatile cleaner.

Upholstery on doors is treated in the same way. Remove all seats that can be easily taken out of the car for cleaning or clean them inside the car using the same procedure. For best results, all the upholstery should be dry before using.

Leather. Genuine or imitation leather (such as Volkswagen's), requires the use of neutral soap which is obtainable at almost any drugstore. Never use volatile cleaners, household detergents or soaps, furniture polishes, oils or bleaches. These may mar the finish of the leather permanently.

There is a natural tendency for leather to show signs of wrinkling; it may also bear the marks from the animal's encounters with barbed wire and other scars. Such marks do not impair its durability or quality. However, wrinkles and scars are natural collectors of dirt and dust, and if this condition continues, the dirt becomes a hard

Modern vinyl upholstery is normally cleaned with household spray cleaners.

and abrasive grit. Under pressure, this grit will cut into the finish and will be the cause of color bleeding and cracking in pressure areas.

To restore the original bright color, use lukeworm water and a neutral soap. Work up a heavy suds and apply only the suds to the leather. Next, go over the leather again, but this time use only a damp, clean cloth. Then wipe the leather with a soft, dry cloth. This same treatment can be used in the treatment of imitation leathers.

Ceilings and floors. Ceilings should be cleaned in the same way as the rest of the upholstery. Use the cleaning agent recommended to the type of material.

Floor carpets are best maintained by frequent and thorough brushing and the use of a vacuum cleaner. If this does not remove the dirt, use a foam-type cleaner to do the job. Do not apply the foam cleaner to more than one square foot of carpet at a time. Use a vacuum cleaner to remove the foam from each processed section. After cleaning, the carpet may be fluffed by working a soft bristle brush gently over the nap. Make sure the carpet is completely dry before using and open the windows to prevent mildew.

If a carpet has been badly stained and must be removed for cleaning, care must be taken to prevent damage. Carpets are cemented or held in place with metal molding, or both. First, remove screws and molding; then turn back a corner of the carpet. Use a wide-blade putty knife to separate the carpet from the cement. Do not pull or jerk the carpet. Avoid getting any of the cement on the face of the carpet. Once removed, use a volatile cleaner to remove oil or grease spots; then clean with foam as outlined earlier.

Vinyl patch kit can make this tear disappear. Start by cutting around tear to eliminate flap.

Apply paste vinyl to hole and smooth down.

Stain removal. Different kinds of stains require different treatments and the use of the wrong treatment may cause even worse damage than the stain itself. However, the removal of the most common stains is well within the ability of the average person. It should be remembered that the sooner after occurrence the stain is treated, the better will be the results.

Battery acid. Saturate affected area with common household ammonia. Allow it to remain on the stain about one minute to neutralize the acid. Rub the spot with a clean cloth wet with cold water. Blot with dry cloth and repeat wet rag application. Action must be immediate to limit destructive action of the acid on the fabric.

Blood. Never try to remove blood with hot water or with soap and water. The action may set the stain and make removal almost impossible. With a clean cloth wet with cold water, rub the blood stain to remove as much of it as possible. As the wet cloth absorbs the stain, fold it to present a clean portion to the stain. Failure to do so will work the stain in a diluted form back into the material. If done soon after the stain's occurrence, this procedure should remove all of it. Should the stain be obstinate after this treatment, apply a bit of household ammonia. Let stand a minute or two, then rub the stain with a clean cloth saturated with cold water. Should the water and ammonia treatment fail to have the desired effect, another remedy must be used. Make a thick paste of corn starch and cold water and apply it to the stain. After the paste has dried, remove it to determine if the paste has absorbed the stain. If not, several applications may be necessary.

Candy. Non-chocolate candy stains are best removed by applying a cloth soaked in very hot water to the stain. Rub gently and allow to dry. Should some sign of stain remain, remove by applying a cloth wet with volatile cleaner. For chocolate candy, the same treatment is recommended except that lukewarm water instead of very hot water should be used.

▲ *Place texturing paper over paste and heat with iron to cure paste.*

▼ *Remove texturing paper and the repair is pertect. Texturing paper has matched repaired area to rest of upholstery. Kit has papers with different textures to match all cars.*

Chewing gum. Apply an ice cube to the gum to harden it. Scrape off hardened particles with a dull knife or edge of a spoon.

If all the gum cannot be removed, moisten it with a volatile cleaner. While the gum is moist, remove it by separating it from the material with a dull knife or spoon.

Fruit, liquor or wine. Apply very hot water with a clean rag, and wet thoroughly. Rub briskly with hot water soaked cloth. If the stain persists, scrape with a dull knife or spoon while wet, and allow to dry. If signs of the stain remain, then rub lightly with a cloth dampened with a volatile cleaner. Never use soap and water since such treatment may permanently set the stain. Also, never use heat to dry the treated area.

Enamel, lacquer or paint. Wet a clean cloth in turpentine. Rub over the stain to remove as much as possible. If the stain is stubborn, saturate with a mixture of one part denatured alcohol and one part benzine. Apply dull knife or spoon to stain and scrape away as much as possible. Repeat if necessary. Apply a final saturation of the mixture and follow immediately with a vigorous rubbing with a cloth soaked with lukewarm soapsuds. Rinse by sponging with cold water.

Tar. Moisten the tar slightly with a volatile cleaner. Use a dull knife to scrape away as much as you can. Rub the spot gently with a cloth dampened with a volatile cleaner until it disappears.

Grease or oil. Remove as much of the grease or oil as is possible with a dull knife blade or kitchen spatula. Rub lightly with a cloth wet with a volatile cleaner over the affected area. Rub from the outer edges of the stain toward the center to reduce the possibility of spreading the stain. Keep applying cleaner on fresh cloths as needed. Confine oil or grease to as small an area as possible by pouring a small quantity of the cleaner directly on the stain. Keep doing this until no more grease or oil can be blotted up. This method also aids in the preventing of a ring formation. If repeated treatments with the solvent still leave a dirty stain, rub the area with lukewarm soapsuds. Rinse with cold water applied with a clean cloth. Always rub from the outside to the center of the stain.

Ice cream. Wet the stain with very hot water applied with a clean cloth. Scrape wet area to remove as much of the stain as possible. Rub vigorously with very hot water again. If the stain is stubborn, rub it with a cloth wet with warm neutral soap suds. Rince by rubbing with a cloth wet with cold water, and allow to dry. If faint signs still remain, rub with a cloth dampened with a volatile cleaner.

Mildew. Rub mildew vigorously with warm soap suds and rinse by rubbing with a cloth dipped in cold water. Old mildew stains are harder to remove. The only treatment recommended for treating discolorations caused by old mildew growths is the use of oxalic acid. Wet the mildew with a 10% oxalic acid solution. Let it soak a minute or so. Next use a blotter or absorbent cloth to blot up acid. Rinse with either hot or cold water. Repeat this sequence as often as is necessary.

Shoe polish. White shoe polish should be allowed to dry completely. With a brush, go over the dry stain briskly until it disappears. Should it persist, moisten it with cold water. Allow to dry, then brush vigorously until it vanishes. Wax or paste type shoe polishes need to be rubbed gently with a cloth dampened with a volatile cleaner. Rub from the outside of the stain to the center, changing to a clean portion of the cloth frequently.

Lipstick. Different brands of lipstick are made of varying components which make stains difficult to remove. Use a spoon or dull knife to scrape away as much as possible. Rub lightly with a cloth dampened with a volatile cleaner. Repeat several times. Should some stain remain after repeated treatments, it is recommended that no more be done to it. Other measures might do more harm than good.

See also: SPOT REMOVAL.